CHAUDHARY RANBIR SINGH UNIVERSITY, JIND

(A Haryana State Government University)

(Established by the Haryana State Legislature Act 28 of 2014 and recognized by UGC Act 1956 U/S 2(f) & 12-B)

Scheme of Examination

for

Mathematics Subject

in

Under Graduate Programmes

as per NEP 2020

Curriculum and Credit Framework for Undergraduate Programmes
(Multiple Entry-Exit, Internships and Choice Based Credit System LOCF)

With effect from the session 2023-24 (in phased manner)

DEPARTMENT OF MATHEMATICS

CHAUDHARY RANBIR SINGH UNIVERSITY, JIND-126102

HARYANA, INDIA

Chaudhary Ranbir Singh University, Jind

Scheme of Examination for the Mathematics Subject in Under Graduate Programmes as per NEP 2020 Curriculum and Credit Framework for Undergraduate Programmes (Multiple Entry-Exit, Internships and Choice Based Credit System LOCF) with effect from the session 2023-24 (in phased manner)

Semester	Course Type	Applicable Scheme	Course Code	Nomenclature of course	Credits			Contact hours L: Lecture P: Practical T: Tutorial			Internal Assessment Marks		End term Examination Marks		Total Marks	Examination hours	
					Total	Theory (T)	Practical (P)	L	P	Total	T	P	T	P		T	P
1	CC-1 MCC-1	Scheme A, B & C	B23-MAT-101	CALCULUS	4	3	1	3	2	5	20	10	50	20	100	3	3
	[illegible]	Scheme C	B23-MAT-102	ADVANCED CALCULUS	4	3	1	3	2	5	20	10	50	20	100	3	3
	CC-1/1	Scheme A, B & D	B23-MAT-103	BASIC CALCULUS	2	1	1	1	2	3	10	5	20	15	50	3	3
	[illegible]	Scheme A, B, C & D	B23-MAT-104	INTRODUCTORY MATHEMATICS	3	2	1	2	2	4	15	5	35	20	75	3	3
2	CC-2 MCC-3	Scheme A, B & C	B23-MAT-201	ALGEBRA AND NUMBER THEORY	4	3	1	3	2	5	20	10	50	20	100	3	3
	DSC-C-02	Scheme C	B23-MAT-202	PROGRAMMING IN C	4	3	1	3	2	5	20	10	50	20	100	3	3

21/07/23

	CC-M2	Scheme A, B & D	B23-MAT-203	BASIC ALGEBRA	2	1	1	1	2	3	10	5	20	15	50	3	3
	[illegible]	Scheme A, B, C & D	B23-MAT-204	MATHEMATICS FOR COMMERCE & SOCIAL SCIENCES	3	2	1	2	2	4	15	5	35	20	75	3	3
3	CC-3 MCC-4	Scheme A, B & C	B23-MAT-301	DIFFERENTIAL EQUATIONS-I	4	3	1	3	2	5	20	10	50	20	100	3	3
	MCC-5	Scheme B & C	B23-MAT-302	GROUPS AND RINGS	4	3	1	3	2	5	20	10	50	20	100	3	3
	[illegible]	Scheme A, B, C & D	B23-MAT-303	MATHEMATICS FOR ALL	3	2	1	2	2	4	15	5	35	20	75	3	3
4	CC-4 MCC-6	Scheme A, B & C	B23-MAT-401	ANALYTICAL GEOMETRY & VECTOR CALCULUS	4	3	1	3	2	5	20	10	50	20	100	3	3
	MCC-7	Scheme B & C	B23-MAT-402	LINEAR ALGEBRA	4	3	1	3	2	5	20	10	50	20	100	3	3
	MCC-8	Scheme B & C	B23-MAT-403	DIFFERENTIAL EQUATIONS-II	4	3	1	3	2	5	20	10	50	20	100	3	3
	DCE-2	Scheme B & C	B23-MAT-404	PROBABILITY THEORY & STATISTICS	4	3	1	3	2	5	20	10	50	20	100	3	3
			Or														

		Scheme B & C	B23-MAT-405	SPECIAL FUNCTIONS	4	3	1	3	2	5	20	10	50	20	100	3	3
5	CC-5 MCC-9	Scheme A, B & C	B23-MAT-501	SEQUENCES AND SERIES	4	3	1	3	2	5	20	10	50	20	100	3	3
		Scheme B & C	B23-MAT-502	MECHANICS-I	4	3	1	3	2	5	20	10	50	20	100	3	3
		Scheme B & C	B23-MAT-503	LINEAR PROGRAMMING	4	3	1	3	2	5	20	10	50	20	100	3	3
			Or														
		Scheme B & C	B23-MAT-504	COMPUTER PROGRAMMING	4	3	1	3	2	5	20	10	50	20	100	3	3
		Scheme B & C	B23-MAT-505	NUMBER THEORY & CRYPTOGRAPHY	4	3	1	3	2	5	20	10	50	20	100	3	3
			Or														
		Scheme B & C	B23-MAT-506	INTEGRAL TRANSFORMS AND FOURIER ANALYSIS	4	3	1	3	2	5	20	10	50	20	100	3	3
6	CC-6 MCC-11	Scheme A, B & C	B23-MAT-601	NUMERICAL ANALYSIS	4	3	1	3	2	5	20	10	50	20	100	3	3
		Scheme B & C	B23-MAT-602	REAL ANALYSIS	4	3	1	3	2	5	20	10	50	20	100	3	3

		Scheme B & C	B23-MAT-603	MECHANICS-II	4	3	1	3	2	5	20	10	50	20	100	3	3
			Or														
		Scheme B & C	B23-MAT-604	CLASSICAL MECHANICS	4	3	1	3	2	5	20	10	50	20	100	3	3
		Scheme B & C	B23-MAT-605	DISCRETE MATHEMATICS	4	3	1	3	2	5	20	10	50	20	100	3	3
			Or														
		Scheme B & C	B23-MAT-606	MATHEMATICAL MODELLING	4	3	1	3	2	5	20	10	50	20	100	3	3
		Scheme B & C			**Total**	**Theory**	**Tutorial/ Practical**	**L**	**T**	**Total**	**Internal Assessment Marks**		**End term Examination Marks**		**Total Marks**	**Examination hours**	
7		Scheme B & C	B23-MAT-701	REAL ANALYSIS-II	4	3	1	3	1	4	30		70		100	3	
		Scheme B & C	B23-MAT-702	COMPLEX ANALYSIS	4	3	1	3	1	4	30		70		100	3	
		Scheme B & C	B23-MAT-703	THEORY OF ORDINARY DIFFERENTIAL EQUATIONS	4	3	1	3	1	4	30		70		100	3	
		Scheme B & C	B23-MAT-704	MECHANICS OF SOLIDS	4	3	1	3	1	4	30		70		100	3	

		Or												
	Scheme B & C	B23-MAT-705	DIFFERENTIAL GEOMETRY	4	3	1	3	1	4	30	70	100	3
	Scheme B & C	B23-MAT-706	PROGRAMMING WITH MATLAB	4	2	2 Practical	2	4	6	15(T)+15(P)	35(T)+35(P)	100	3 +3
	Scheme B & C	B23-MAT-801	ABSTRACT ALGEBRA	4	3	1	3	1	4	30	70	100	3
	Scheme B & C	B23-MAT-802	TOPOLOGY	4	3	1	3	1	4	30	70	100	3
	Scheme B & C	B23-MAT-803	MEASURE AND INTEGRATION	4	3	1	3	1	4	30	70	100	3
	Scheme B & C	B23-MAT-804	FIELD THEORY	4	3	1	3	1	4	30	70	100	3
		Or											
	Scheme B & C	B23-MAT-805	FLUID MECHANICS	4	3	1	3	1	4	30	70	100	3
	Scheme B & C	B23-MAT-806	MATHEMATICAL SOFTWARES	4	0	4 Practical	0	8	8	30	70	100	3

Research	Scheme B & C	B23-MAT-807	DISSERTATION	12					300	300		

Scheme of VAC, SEC and VOC courses

Semester	Course Type	Applicable Scheme	Course Code	Nomenclature of the Course	Credits			Contact hours L: Lecture P: Practical			Internal Assessment Marks		End term Examination Marks		Total Marks	Examination hours	
					Total	Theory (T)	Practical (P)	L	P	Total	T	P	T	P		T	P
3/4	VAC-3	Scheme A, B, C & D	B23-VAC-308	Mathematics in India: From Vedic Period to Modern Times	2	2	0	2	0	2	15	0	35		50	3	
4	VAC-4	Scheme A, B, C & D	B23-VAC-418	Mathematics in Everyday Life	2	2	0	2	0	2	15	0	35		50	3	
2	SEC-2	Scheme A, B, C & D	B23-SEC-203	Calculation Skills with Vedic Mathematics-I	3	2	1	2	2	4	15	5	35	20	75	3	3
2	SEC-2	Scheme A, B, C & D	B23-SEC-225	Numerical Ability Enhancement Skills	3	2	1	2	2	4	15	5	35	20	75	3	3

	SEC-3	Scheme A, B, C & D	B23-SEC-303	Calculation Skills with Vedic Mathematics-II	3	2	1	2	2	4	15	5	35	20	75	3	3
3	SEC-3	Scheme A, B, C & D	B23-SEC-324	Learning MATLAB Skills	3	2	1	2	2	4	15	5	35	20	75	3	3
3	SEC-3	Scheme A, B, C & D	B23-SEC-326	Quantitative Aptitude	3	2	1	2	2	4	15	5	35	20	75	3	3
6	SEC-4	Scheme A, B, C & D	B23-SEC-406	Basic Mathematical Techniques	3	2	1	2	2	4	15	5	35	20	75	3	3

Course composition- Theory/ Theory +Tutorial			
Course Credit	Internal Assessment marks	End term exam marks	Total marks
2	15	35	50
3	25	50	75
4	30	70	100

Course composition- Theory + Practical					
Course Credit	Theory		Practical		Total marks
Theory +Practical	Internal Assessment marks	End term exam marks	Internal Assessment marks	End term exam marks	
1+1	10	20	5	15	50
2+1	15	35	5	20	75
2+2	15	35	15	35	100
3+1	20	50	10	20	100
0+4	NA	NA	30	70	100

1. Internal assessment (30%) shall be broadly based on the following defined components of;
   a. Class participation
   b. Seminar/Presentation/Assignment/Quiz/class test, etc.
   c. Mid Term Exam

Total Internal Assessment Marks (Theory)	Class Participation	Seminar/Presentation/Assignment/Quiz/class test, etc.	Mid-Term Exam
10	4	1	6
15	4	4	7
20	5	5	10
25	5	7	13
30	5	10	15

Total Internal Assessment Marks (Practicum)	Class Participation	Seminar/Demonstration/Viva-Voce/Lab record, etc.	Mid-Term Exam
5		5	NA
10		10	NA
15	5	10	NA
30	5	10	15

CC-1 /MCC-1	
Session: 2023-24	
Part A – Introduction	
Subject	Mathematics
Semester	I
Name of the Course	Calculus
Course Code	B23-MAT-101
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC
Level of the course	100-199
Pre-requisite for the course (if any)	Mathematics as a subject at 4.0 Level (Class-XII)
Course Learning Outcomes(CLOs):	**After completing this course, the learner will be able to:** 1. Gain knowledge of the concepts and theory of limit, continuity and differentiability of functions. Attain skills of calculating the limit of functions and examining the continuity and differentiability of different types of functions, and perform successive differentiation of functions. To apply the procedural knowledge to obtain the series expansions of functions which find multidisciplinary applications. 2. Understand concepts of asymptotes and curvature, the geometrical meaning of these terms and to have procedural knowledge to solve related problems. 3. Determine singular points of a curve and classify them. Understand the concept of rectification of curves and derive the reduction formulae. 4. Have theoretical knowledge and practical skills to evaluate the area bounded by the curves, and volume and surface area of solids formed by revolution of curves.
CLO 5 is related to the practical component of the course.	5. Attain cognitive and technical skills required for solving different problems of calculus associated with

	tracing of curves, determination of curvature, and rectification of curves, volume and surface area of solids of revolution. Have technical and practical skills of solving calculus problems related to differentiation and integration of functions by using MAXIMA software.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Examination Marks	50	20	70
Examination Time	3 Hours	3 Hours	

Max. Marks:100

Part B- Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	ε-δ definition of limit and continuity of a real valued function, Basic properties of limits, Types of discontinuities, Differentiability of functions, Application of L'Hospital rule to indeterminate forms, Successive differentiation, Leibnitz theorem, Taylor's and Maclaurin's series expansion with different forms of remainder.	12
II	Asymptotes: Horizontal, vertical and oblique asymptotes for algebraic curves, Asymptotes for polar curves, Intersection of a curve and its asymptotes, Curvature and radius of curvature of curves (cartesian, parametric, polar & intrinsic forms), Newton's method, Centre of curvature and circle of curvature.	12

III	Multiple points, Node, Cusp, Conjugate point, Tests for concavity and convexity, Points of inflexion, Tracing of curves, Reduction formulae.	12
IV	Rectification, intrinsic equation of a curve, Quadrature, Area bounded by closed curves, Volumes and surfaces of solids of revolution.	12
	Practical	
	The practical component of the course has two parts, Problem Solving and Practical's using MAXIMA software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLO) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program. **(A) Problem Solving**- Questions related to the following problems will be solved and their record will be maintained in the Practical Notebook: 1. Problems of curve tracing when equation is given in Cartesian coordinates. 2. Problems of curve tracing when equation is given in Parametric form. 3. Problems of curve tracing when equation is given in Polar coordinates. 4. Problem of determination of length of a curve expressed in Cartesian coordinates. 5. Problem of determination of length of a curve expressed in Polar coordinates.	30

	6. Problem of determination of radius of curvature expressed in Cartesian coordinates. 7. Problem of determination of radius of curvature expressed in Polar coordinates. 8. Problem of determination of radius of curvature expressed in Parametric form. 9. Problem of determination of volumes and surfaces of solids of revolution for Cartesian curve. 10. Problem of determination of volumes and surfaces of solids of revolution for Parametric curve. 11. Problem of determination of volumes and surfaces of solids of revolution for Polar curve. **(B)The following practicals will be done using MAXIMA software and their record will be maintained in the practical note book:** 1. Learn to use basic operators and functions in Maxima software. 2. Simplify algebraic expressions and expressions containing radicals, logarithms, exponentials and trigonometric functions. 3. Expand algebraic, rational, trigonometric and logarithmic expressions. 4. Find derivatives of algebraic, trigonometric, exponential and logarithmic functions. 5. Find derivatives of functions involving above mentioned functions. 6. Problems of successive differentiation. 7. Find indefinite integrals of different functions. 8. Find definite integrals of different functions. 9. To plot curves involving Cartesian, parametric and polar forms. 10. To demonstrate singular points.	
Suggested Evaluation Methods		

Internal Assessment:	End Term Examination:
➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write up and execution of the program

Part C-Learning Resources

Recommended Books:

1. Howard Anton, I. Bivens & Stephan Davis (2021). *Calculus* (12th edition). J. Wiley & Sons.
2. Gabriel Klambauer (1986). *Aspects of Calculus* (4th edition). Springer.
3. Wieslaw Krawcewicz & Bindhyachal Rai (2003). *Calculus with Maple Labs*. Alpha Science Int'l Ltd.
4. Gorakh Prasad (2016). *Differential Calculus* (19th edition). Pothishala Pvt. Ltd.
5. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). *Thomas' Calculus* (14th edition). Pearson Education.
6. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith (2002). *Calculus* (3rd edition). Dorling Kindersley (India) Pvt. Ltd.

MCC-2

Session: 2023-24	
Part A – Introduction	
Subject	Mathematics
Semester	I
Name of the Course	Advanced Calculus
Course Code	B23-MAT-102
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	MCC
Level of the course	100-199
Pre-requisite for the course (if any)	Mathematics as a subject at 4.0 Level (Class-XII).
Course Learning Outcomes(CLOs):	**After completing this course, the learner will be able to:** 1. Have theoretical knowledge about various mean value theorems and their geometrical interpretations. 2. Learn conceptual variations while advancing from dealing with functions of one variable to several variables in calculus and discuss limit and continuity of such functions. Have deeper understanding of Euler's theorem and Taylor's theorem and practice to attain skill in multidisciplinary contexts. 3. Know about differentiability of real valued functions of two variables and understand Young's, theorem Schwarz's theorem and implicit function theorem. Determine maxima and minima of functions of two variables, learn Lagrange's method of undetermined multipliers and exploit this procedural knowledge for various realistic optimization problems. 4. Understand and acquire theoretical knowledge about Jacobians, Beta and Gamma functions, with acquisition of skill to analyse various methods of integration and evaluate double and triple integrals which find application in the determination of areas and volumes.

CLO 5 is related to the practical component.	5. Attain cognitive skills required for solving problems associated with continuity, differentiability of functions of several variables and applications of double and triple integrals. Have technical and practical skills of solving problems related to plotting of curves in two and three dimensions and evaluating double and triple integrals by using built in functions of MAXIMA software.		
	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Examination Marks	50	20	70
Examination Time	3 Hours	3 Hours	

Max. Marks:100

Part B- Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Continuous functions, Sequential criterion for continuity, Properties of continuous functions, Uniform continuity, Chain rule of differentiability, Mean value theorems: Rolle's Theorem, Lagrange's mean value theorem and their geometrical interpretations, Cauchy mean value theorem. Taylor's theorem with various forms of remainders.	12
II	Limit and continuity of real valued functions of two variables, Partial differentiation. Total Differentials; Composite functions & implicit functions. Change of variables. Homogenous functions & Euler's theorem on homogeneous functions. Taylor's theorem for functions of two variables.	12

III	Differentiability of real valued functions of two variables. Young's theorem, Schwarz's theorem, Implicit function theorem. Extrema of functions of two and more variables: Maxima, minima and saddle points. Lagrange's method of undetermined multipliers.	12
IV	Jacobians. Beta and Gamma functions, Relation between Beta and Gamma functions, Legendre's duplication formula. Double integration over rectangular and non rectangular regions, Double integrals in polar co-ordinates. Change of order of integration. Volume by triple integrals, Triple integration in cylindrical and spherical co-ordinates. Dirichlet integrals, Liouville's extension of Dirichlet's integral.	12
	Practical	
	This course has two components, Problem Solving and Practical's using MAXIMA software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (COs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program. **(A) Problem Solving**- Questions related to the following problems will be solved and record of those will be maintained in the Practical Notebook: 1. Problems to check continuity of functions of several variables. 2. Problems of checking differentiability of functions of several variables. 3. Problems of finding maxima /minima of functions of two variables.	30

	4. Problems of determination of surface area through application of double integrals in Cartesian and Polar coordinates. 5. Problems of determination of volume using triple integrals. 6. Problem to demonstrate uniform continuity of a function of single variable. 7. Problem to demonstrate the existence of a continuous function which is not uniformly continuous. 8. Problem to demonstrate that for a function f of two variables f_{xy} need not be equal to f_{yx}. **(B)The following practicals will be done using MAXIMA software and record of those will be maintained in the practical note book:** 1. To find partial derivatives of a function. 2. To find total differential of a function of several variables. 3. To plot a curve for a function of two variables. 4. To plot a curve for a function of three variables. 5. To solve practical problems using method of Lagranges multipliers. 6. To evaluate double integrals. 7. To evaluate triple integrals. 8. To demonstrate Young's theorem.	

Suggested Evaluation Methods	
Internal Assessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write up and execution of the program
Part C-Learning Resources	

Recommended Books:

1. Howard Anton, I. Bivens & Stephan Davis (2021). *Calculus* (12th edition). Wiley India.

2. Gabriel Klambauer (1986). *Aspects of Calculus*. Springer-Verlag.

3. Wieslaw Krawcewicz & Bindhyachal Rai (2003). *Calculus with Maple Labs*. Narosa.

4. Gorakh Prasad (2016). *Differential Calculus* (19th edition). Pothishala Pvt. Ltd.

5. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). *Thomas' Calculus* (14th edition). Pearson Education.

6. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith (2011). *Calculus* (3rd edition). Pearson Education. Dorling Kindersley (India) Pvt. Ltd.

7. Jerrold Marsden, Anthony J. Tromba & Alan Weinstein (2009). *Basic Multivariable Calculus*, Springer India Pvt. Limited.

8. James Stewart (2012). *Multivariable Calculus* (7th edition). Brooks/Cole. Cengage.

9. Murray R Spiegel & Robert Wrede (2011). *Schaum's Advanced Calculus*.(3rd edition). McGraw Hill Publication.

CC-M1

Session: 2023-24	
Part A - Introduction	
Subject	Mathematics
Semester	1
Name of the Course	Basic Calculus
Course Code	B23-MAT-103
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-M
Level of the course	100-199
Pre-requisite for the course (if any)	Mathematics as a subject at 4.0 Level (Class-XII)
Course Learning Outcomes(CLOs):	**After completing this course, the learner will be able to:** 1. Gain knowledge of the concepts of limit, continuity and differentiability of functions, calculate the limit of functions and examine the continuity and differentiability of different types of functions, and perform successive differentiation of functions and obtain their series expansions, which find multidisciplinary applications within the chosen field of learning. 2. Have deeper understanding of Taylor's and Maclaurin's theorem and use this knowledge for series expansion of various functions, which find multidisciplinary applications within the chosen field of learning. 3. Understand and acquire procedural skills required for accomplishing assigned tasks of determining asymptotes and analyze them geometrically. 4. Comprehend the process of deriving reduction formulae and use this skill to solve typical integrals easily and quickly.

CLO 5 is related to the practical component.	5. Attain cognitive and theoretical skills to find successive derivatives of a function, higher derivative of the product of two functions using Leibnitz' s rule and apply this skill for expansion of functions. Have technical and practical skills of solving problems related to differentiation and integration of functions by using built in functions of MAXIMA software.		
Credits	Theory	Practical	Total
	1	1	2
Contact Hours	1	2	3
Internal Assessment Marks	10	5	15
End Term Examination Marks	20	15	35
Contact Hours	3 Hours	3 Hours	
Max. Marks:50			

Part B- Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Limit and continuity of a real valued function, basic properties of limits, types of discontinuities, Differentiability of functions. Application of L'Hospital rule to Indeterminate forms.	4
II	Successive differentiation, Leibnitz theorem (statement only), Taylor's and Maclaurin's series expansions with different forms of remainder.	4
III	Asymptotes: Horizontal, vertical and oblique asymptotes for algebraic curves, Asymptotes for polar curves, Intersection of a curve and its asymptotes.	4

IV	Reduction formulae.	4
	Practical	
	This course has two components, Problem Solving and Practical's using MAXIMA software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program. **(A) Problem Solving**- Questions related to the following problems will be solved and their record will be maintained in the Practical Notebook: 1. Practical problems to check the limit and continuity of a function. 2. Practical problems to check the differentiability of a function. 3. Practical problems of finding derivatives of algebraic, trigonometric, exponential and logarithmic functions. 4. Practical problems of finding n^{th} derivatives using Leibnitz theorem. 5. Practical problems related to application of Taylor's theorem. 6. Practical problems to find the asymptotes of a given	30

	algebraic curve. 7. Practical application of L'Hospital rule to evaluate indeterminate forms. 8. Practical problems to find the asymptotes of a polar curve. 9. Practical problems to find Maclaurin's series expansion of various functions. 10. Practical problems based on reduction formulae. **(B)**The following practicals will be done using MAXIMA software and record of those will be maintained in the practical note book: 1. Introduce basic operators and functions in Maxima software. 2. Simplify algebraic expressions and expressions containing radicals, logarithms, exponentials and trigonometric functions. 3. Expand algebraic, rational, trigonometric and logarithmic expressions. 4. Find derivatives of algebraic, trigonometric, exponential and logarithmic functions. 5. Find derivatives of functions involving above mentioned functions. 6. Find indefinite integrals of different functions. 7. Find definite integrals of different functions.	
Suggested Evaluation Methods		
Internal Assessment: ➢ **Theory 10** • Class Participation: 4 • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: 6 ➢ **Practicum 5** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 5 • Mid-Term Exam:		**End Term Examination:** ➢ **Theory 20** Written Examination ➢ **Practicum 15** Lab record, viva-voce, write up and execution of the program
Part C-Learning Resources		

Recommended Books:

1. Howard Anton, I. Bivens & Stephan Davis (2021). *Calculus* (12th edition). Wiley India.
2. Gabriel Klambauer (1986). *Aspects of Calculus*. Springer-Verlag.
3. Wieslaw Krawcewicz & Bindhyachal Rai (2003). *Calculus with Maple Labs*. Narosa.
4. Gorakh Prasad (2016). *Differential Calculus* (19th edition). Pothishala Pvt. Ltd.
5. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). *Thomas' Calculus* (14th edition). Pearson Education.
6. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith (2011). *Calculus* (3rd edition). Pearson Education. Dorling Kindersley (India) Pvt. Ltd.

MDC-1

Session: 2023-24	
Part A–Introduction	
Subject	Mathematics
Semester	I
Name of the Course	Introductory Mathematics
Course Code	B23-MAT-104
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	MDC
Level of the course	100-199
Pre-requisite for the course (if any)	NA
Course Learning Outcomes(CLOs):	**After completing this course, the learner will be able to:** 1. Gain the knowledge of set theory, types of sets and operations on sets. Understand various concepts of matrices and determinants, and acquire the cognitive skills to apply different operations on matrices and determinants. 2. Have the knowledge of the basic concepts of complex numbers and acquire skills to solve linear inequalities and quadratic equations. 3. Gain the knowledge of the concepts of Arithmetic progression, Geometric progression and Harmonic progression, and find A.M., G.M. and H.M. of given numbers. 4. Have the conceptual knowledge of straight lines and circles. Find out the slope of a line, angle between two lines, and know about various forms of a straight line and the standard form of a circle.
CLO 5 is related to the practical components of the course.	5. Attain the skills to make use of the learnt concepts of Introductory Mathematics in multidisciplinary learning contexts and to know their applications.

	Theory	Practical	Total
Credits	2	1	3
Contact Hours	2	2	4
Internal Assessment Marks	15	5	20
End Term Examination Marks	35	20	55
Examination Time	3 Hrs	3Hrs	

Max. Marks:75

Part B-Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 7 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Sets and their representations, Empty set, Finite and infinite sets, Subsets, Equal sets, Power sets, Universal set, Union and intersection of sets, Difference of two sets, Complement of a set, Venn diagram, De-Morgan's laws and their applications. An introduction to matrices and their types, Operations on matrices, Symmetric and skew-symmetric matrices, Minors, Co-factors. Determinant of a square matrix, Adjoint and inverse of a square matrix, Solutions of a system of linear equations up to order 3.	8
II	Complex numbers, Operations on complex numbers, Modulus and argument of a complex number. Linear inequalities, Algebraic solutions of linear inequalities in two variables and their graphical representation. Quadratic equations, Solution of quadratic equations.	8

III	Arithmetic progression, Geometric progression, Harmonic progression, Arithmetic mean (A.M.), Geometric mean (G.M.), Harmonic mean (H.M.), Relation between A.M., G.M. and H.M.	8
IV	Straight lines: Slope of a line and angle between two lines, Different forms of equation of a line: Parallel to co-ordinate axes, Point-slope form, Slope-intercept form, Two-point form, General form; Distance of a point from a straight line. Standard form of a circle and its properties.	8
	Practical	
	The examiner will set 4 questions at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve 2 questions. The evaluation will be done on the basis of practical record, viva-voce and written examination. **Problem Solving**- Questions related to the practical problems based on following topics will be worked out and record of those will be maintained in the Practical Note Book: 1. Problems related to union, intersection, difference and complement of sets. 2. Problems based on De Morgan's Laws. 3. Problems related to Venn diagrams. 4. Problems to find inverse of a matrix. 5. Problems to find determinant of a square matrix of order 3. 6. Problems to find nth term of A.P., G.P. and H.P. 7. Problems to find sum of n terms of A.P., G.P. and H.P. 8. Problems to find A.M., G.M. and H.M. of given numbers.	30

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	9. Problems to find modulus and argument of a complex number. 10. Problems involving formulation and solution of quadratic equations in one variable. 11. Problems to represent solutions of linear inequalities graphically. 12. Problems based on angle between two lines. 13. Problems involving straight lines and their slope. 14. Problems related to a circle.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory 15** • Class Participation: 4 • Seminar/presentation/assignment/quiz/class test etc.: 4 • Mid-Term Exam: 7 ➢ **Practicum 5** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 5 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 35** Written Examination ➢ **Practicum 20** Lab record, viva-voce, written examination.

Part C-Learning Resources

Recommended Books:

1. C. Y. Young (2021). *Algebra and Trigonometry*. Wiley.
2. S.L. Loney (2016). *The Elements of Coordinate Geometry (Cartesian Coordinates)*(2nd Edition). G.K. Publication Private Limited.
3. Seymour Lipschutz and Marc Lars Lipson (2013). *Linear Algebra*. (4th Edition) Schaum's Outline Series, McGraw-Hill.
4. C.C. Pinter (2014). *A Book of Set Theory*. Dover Publications.
5. J. V. Dyke, J. Rogers and H. Adams (2011). *Fundamentals of Mathematics* (10th Edition), Brooks/Cole.
6. A.Tussy, R. Gustafson and D. Koenig (2010). *Basic Mathematics for College Students* (4th Edition). Brooks Cole.

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CC-2/MCC-3

Session: 2023-24	
Part A – Introduction	
Subject	Mathematics
Semester	II
Name of the Course	Algebra and Number Theory
Course Code	B23-MAT-201
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC
Level of the course	100-199
Pre-requisite for the course (if any)	Mathematics as a subject at level 4.0 (Class XII)
Course Learning Outcomes(CLOs):	After completing this course, the learner will be able to: 1. Gain knowledge of the concepts of symmetric, skew-symmetric, Hermitian, skew-Hermitian, Orthogonal and Unitary matrices, Linear dependence and independence of rows and columns of a matrix. Have knowledge of procedure and cognitive skills used in calculating rank of a matrix, eigen values, characteristic equation, minimal polynomial of a matrix and technical skills used in solving problems based on Cayley- Hamilton theorem. 2. Have knowledge of the concepts used in solving problems based on relations between the roots and coefficients of general polynomial equation

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	in one variable, solutions of polynomial equations having conditions on roots, common roots and multiple roots. Understand Descarte's rule of signs and learn cognitive and technical skills required in assessing nature of the roots of an equation and solving problems based on these. 3. Have deeper and procedural knowledge required for solving cubic and biquadratic equations used in Mathematics as well as many other learning fields of study. To understand the basic concepts of number theory and their applications in problem solving and life- long learning. 4. Have knowledge of concepts, facts, principles and theories of Linear Congruences, Fermat's theorem, Euler's theorem, Wilson's theorem and its converse, Chinese Remainder theorem. Attain cognitive skills used in solving linear Diophantine equations in two variables.
CLO 5 is related to the practical component of the course.	5. Attain cognitive and technical skills required to formulate and solve practical problems involving rank of a matrix, inverse of a matrix, Cardon's method, Ferrari's method, Descarte's method, Cayley-Hamilton theorem, Euler's theorem and Chinese Remainder theorem. Have technical and practical skills required for solving algebraic equations, finding inverse and eigen values of matrices by using built in functions of MAXIMA software.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End term Examination Marks	50	20	70
Examination Time	3 Hours	3 Hours	

Max. Marks:100

Part B- Contents of the Course

Instructions for Paper- Setter

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Symmetric, Skew symmetric, Hermitian and skew Hermitian matrices, Elementary operations on matrices, Rank of a matrix, Inverse of a matrix, Linear dependence and independence of rows and columns of matrix, Row rank and column rank of a matrix, Eigen values, Eigen vectors and characteristic equation of a matrix, Minimal polynomial of a matrix, Cayley-Hamilton theorem and its use in finding the inverse of a matrix, Unitary and orthogonal matrices.	12
II	Relations between the roots and coefficients of general polynomial equation in one variable, Solutions of polynomial equations having conditions on roots. Common roots and multiple roots, Transformation of equations, Nature of the roots of an equation, Descarte's rule of signs.	12

III	Solutions of cubic equations (Cardon's method), Biquadratic equations and their solutions. Divisibility, Greatest common divisor (gcd), Least common multiple (lcm), Prime numbers, Fundamental theorem of arithmetic.	12
IV	Linear congruences, Fermat's theorem, Euler's theorem, Wilson's theorem and its converse, Chinese Remainder theorem, Linear Diophantine equations in two variables.	12
	Practical	
	The practical component of the course has two parts, Problem Solving and Practical's using MAXIMA software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program. **A) Problem Solving: Questions related to the following problems will be worked out and record of those will be maintained in the Practical Notebook:** 1. Problems to find the row rank and column rank of a matrix. 2. Problems to find the eigen values and eigen vectors of a matrix. 3. Problems to find the minimal polynomial of a matrix.	30

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	4. Problems of finding inverse of a matrix using Cayley-Hamilton theorem. 5. Problems of solving cubic equations by Cardon's method. 6. Problems of solving biquadratic equations by Descarte's method. 7. Problems of solving biquadratic equations by Ferrari's method. 8. Problems to find gcd and lcm of two integers. 9. Problems to find solution of linear congruence using Euler's theorem. 10. Problems to find common solution of congruences using Chinese remainder theorem. **B) The following practicals will be done using MAXIMA Software and their record will be maintained in the practical note Book:** 1. To find roots of algebraic equations using MAXIMA. 2. To find multiple roots of algebraic equations using MAXIMA 3. To find the value of a determinant using MAXIMA. 4. To compute inverse of a square matrix using MAXIMA. 5. To find Eigen values of a square matrix using MAXIMA. 6. To find Eigen vectors of a square matrix using MAXIMA. 7. To solve system of linear equations using MAXIMA. 8. Problems to find gcd and lcm of two or more	

	integers using MAXIMA. 9. Problems of solving biquadratic equations by Ferrari's method using MAXIMA.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: - • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam: -	**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write up and execution of the program

Part C- Learning Resources

Recommended Books/e-resources:

1) Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence (2022). *Linear Algebra* (5th edition). Prentice Hall of India Pvt. Ltd.
2) Seymour Lipschutz and Marc Lars Lipson (2013). *Linear Algebra*. (4th Edition) Schaum's Outline Series, McGraw-Hill.
3) K. B. Dutta (2004). *Matrix and Linear Algebra*. Prentice Hall of India Pvt. Ltd.
4) Vivek Sahai & Vikas Bist (2013). *Linear Algebra* (2nd edition). Narosa Publishing House.
5) I. Niven (1991). *An Introduction to the Theory of Numbers* (5th edition). John Wiley & Sons.
6) H.S. Hall and S.R. Knight (2023). *Higher Algebra* (7th edition). Arihant Publications.
7) Leonard Eugene Dickson (2009). *First Course in the Theory of Equations*. The Project Gutenberg EBook (http://www.gutenberg.org/ebooks/29785).

DSEC-I

Session: 2023-24	
Part A – Introduction	
Subject	Mathematics
Semester	II
Name of the Course	PROGRAMMING IN C
Course Code	B23-MAT-202
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSEC
Level of the course	100-199
Pre-requisite for the course (if any)	Mathematics as a subject at level 4.0(Class XII)
Course Learning Outcomes (CLOs):	**After completing this course, the learner will be able to:** 1. Gain the knowledge and understanding of the concepts of C programming language. Learn elements of C, data types, constants and variables, operations and operators, statements and expressions. Attain the skills to write C programs. 2. Have the conceptual knowledge of Input/ Output functions in C, decision making statements in C. Acquire the technical skills to develop C programs for practical problems. 3. Gain the knowledge of loops and arrays, their types, characteristics and structures. Attain the skills to write C programs with loops and arrays

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CLO 5 is related to practical component of the course	for solving mathematical and realistic problems. 4. Have the procedural knowledge required for performing skilled task associated with C language. Learn strings of characters, their declaration, input/output, operations on strings and functions which handle strings. Acquire knowledge of the concepts of user defined functions in C. Attain the skills to write codes in C using functions. 5. Attain cognitive and technical skills for solving problems with the C programming language. Have hands-on experience to run and debug programs in C for different mathematical and other practical problems of daily or scientific use.

	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Examination Marks	50	20	70
Examination Time	3Hrs	3Hrs	

Max. Marks:100

Part B-Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Overview of C: Introduction and importance of C, Basic structure of a C program, Executing a C program. Elements of C: C character set, C tokens, Identifiers and keywords, Constants and variables, Data types, Assignment statement, Symbolic constants. Operators and expressions: Arithmetic, relational, logical, bitwise, unary, assignment, conditional and special operators. Arithmetic expressions, Evaluation of arithmetic expression, Type casting and conversion, Operators hierarchy.	12
II	Input/output: Unformatted and formatted I/O functions, Input functions viz. scanf(), getch(), getche(), getchar(), gets(), Output functions viz. printf(), putch(), putchar(), puts(). Decision making and branching: Decision making with IF statement, if-else statement, Nested IF statement, else-if ladder, switch statement, goto statement.	12
III	Looping: For, while and do-while loops, Jumps in loops, break, continue statement. Arrays: Definition, Types, Initialization, Processing an array.	12
IV	Character Strings: Declaration and initialization, Reading and writing, Arithmetic operations on characters, Putting strings together, Comparison of strings, String handling functions. User defined functions: Need for user defined functions, Form of C functions, Return values and their types, Calling a function,	12

	Category of functions, Nesting of functions, Recursion, Functions with arrays, Scope of variables in functions, ANSI C functions.	
	Practical	
	The practical component will involve coding based on Programming in C for mathematical and scientific problems. The examiner will set 4 programs at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to execute two programs. The evaluation will be done on the basis of practical record, viva-voce, write-up and execution of the program. **Practical**: The following practicals will be done using the programming language C and record of those will be maintained in the practical Note Book: 1. To find greatest and smallest of three numbers. 2. To find the roots of a quadratic equation. 3. To check whether a given year is leap year or not. 4. To prepare electricity bill. 5. To calculate the Letter grades and Grade points of a student according to marks obtained in 4 subjects on the basis of following table:	30

Marks	Grade Point	Letter Grade
>85	10	O (Outstanding)
>75	9	A+ (Excellent)
>65	8	A (Very Good)
>55	7	B+ (Good)
>50	6	B (Above Average)
>40	5	C (Average)
40	4	P (Pass)
<40	0	F (Fail)

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	6. To check a given number for being palindrome or Armstrong. 7. To generate Fibonacci sequence. 8. Write a function to check a given number for being prime number. Use the same to generate the prime numbers less than or equal to a given number m. 9. To find area of circle, triangle and rectangle depending on choice using switch statement. 10. To find sum of cosine series and sine series up to n terms. 11. To find sum of any n numbers. 12. To find transpose of a matrix. 13. To find sum and product of two matrices. 14. To find factorial of a number using (a) iteration (b) function. 15. To sort given numbers in ascending/descending order using (a) selection sort (b) bubble sort	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write-up and execution of programs.

Part C-Learning Resources

Recommended Books:

1) E. Balagurusamy (2019). *Programming in ANSI C* (8th Edition). Tata McGraw-Hill Publishing Co. Ltd.

2) R. Threja (2016). *Computer Fundamentals and Programming in C* (2nd Edition), Oxford University Press.

3) B. S. Gottfried (1998). *Theory and Problems of Programming with C*. Tata McGraw-

Hill Publishing Co. Ltd.

4) V. Rajaraman (1994). *Computer Programming in C.* Prentice Hall of India.

5) B.W. Kernighan and D.M. Ritchie (1988). *The C Programming Language* (2nd Edition). Pearson.

CC-M2

Session: 2023-24	
Part A – Introduction	
Subject	Mathematics
Semester	II
Name of the Course	Basic Algebra
Course Code	B23-MAT-203
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-M
Level of the course	100-199
Pre-requisite for the course (if any)	Mathematics as a subject at 4.0 level (Class XII)
Course Learning Outcomes (CLOs):	After completing this course, the learner will be able to: 1. Gain knowledge of facts, principles and theories to determine rank of a matrix, eigen values, eigen vectors, characteristic equation and minimal polynomial of square matrices. 2. Have procedural knowledge, cognitive and technical skills of solving problems based on Cayley-Hamilton theorem. Gain knowledge about unitary and orthogonal matrices and have skills to solve problems related to them. 3. Understand consistency of homogeneous and non-homogeneous system of linear equations and to learn cognitive and technical skills required for solving such type of problems

CLO 5 is related to the practical component of the course.	using matrices. 4. Have procedural knowledge to determine relation between roots and coefficients of a general polynomial and find solutions of polynomial equations having conditions on roots. 5. Attain cognitive and technical skills required for using relevant methods and procedures to solve algebraic equations, finding inverse and eigen values of matrices. Have technical and practical skills of solving algebraic equations, finding inverse and eigen values of matrices by using built in functions of MAXIMA software.

Credits	Theory	Practical	Total
	1	1	2
Contact Hours	1	2	3
Internal Assessment Marks	10	5	15
End term Examination Marks	20	15	35
Examination Time	3 Hours	3 Hours	

Max. Marks:50

Part B - Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Rank of a matrix, Row rank and column rank of a matrix, Eigen values, Eigen vectors and the characteristic equation of a matrix, Minimal polynomial of a matrix.	4
II	Cayley-Hamilton theorem and its use in finding the inverse of a matrix, Unitary and orthogonal matrices.	4
III	Applications of matrices to a system of linear (both homogeneous and non–homogeneous) equations, Theorems on consistency of a system of linear equations.	4
IV	Relations between the roots and coefficients of general polynomial equation in one variable, Solutions of polynomial equations having conditions on roots.	4
	Practical	
	The practical component of the course has two parts, Problem Solving and Practical's using MAXIMA software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program. A) **Problem Solving**- Questions related to the practical applications based on following problems will be worked out and record of those will be maintained in the Practical Note Book:	30

	1. Problems to find the row rank and column rank of a matrix. 2. Problems to find the eigen values and eigen vectors of a matrix. 3. Problems of finding inverse of a matrix using Cayley-Hamilton theorem. 4. Problems to find the minimal polynomial of a matrix. 5. Problems to check the consistency of a system of linear equations. **B) The following practicals will be worked out using MAXIMA Software and their record will be maintained in the Practical Notebook:** 1. To find roots of algebraic equations using MAXIMA. 2. To find the value of determinant using MAXIMA. 3. To compute inverse of a square matrix using MAXIMA. 4. To find Eigen values and Eigen vectors of a square matrix using MAXIMA. 5. To solve system of linear equations using MAXIMA.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** 10 • Class Participation: 4 • Seminar/presentation/assignment/quiz/class test etc.:- • Mid-Term Exam: 6 ➢ **Practicum** 5 • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 5 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory** 20 Written Examination ➢ **Practicum** 15 Lab record, viva-voce, write up and execution of the program

Part C-Learning Resources

Recommended Books/e-resources:

1. Stephen H. Friedberg Arnold J. Insel Lawrence E. (2022). *Linear Algebra* (5th edition). Prentice Hall of India Pvt. Ltd.
2. Seymour Lipschutz and Marc Lars Lipson (2013). *Linear Algebra*. (4th Edition) Schaum's Outline Series, McGraw-Hill.
3. K. B. Dutta (2004). *Matrix and Linear Algebra*. Prentice Hall of India Pvt. Ltd.
4. H.S. Hall and S.R. Knight (2023). *Higher Algebra* (7th edition). Arihant Publications.
5. Leonard Eugene Dickson (2009). *First Course in the Theory of Equations*. The Project Gutenberg EBook (http://www.gutenberg.org/ebooks/29785).

MDC-2

Session: 2023-24	
Part A – Introduction	
Subject	Mathematics
Semester	II
Name of the Course	Mathematics for Commerce and Social Sciences
Course Code	B23-MAT-204
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	MDC
Level of the course	100-199
Pre-requisite for the course (if any)	NA
Course Learning Outcomes(CLOs):	**After completing this course, the learner will be able to:** 1. Understand and have the procedural knowledge of the concepts of matrices and determinants to solve simultaneous linear equations. 2. Gain the knowledge to find derivatives and integration of simple functions related to commerce and social sciences. Acquire skills to make use of derivatives and integration in realistic problems of the discipline. 3. Have the conceptual knowledge of compound interest, annuity, loan, debenture and sinking funds and attain skills to use these concepts in problem solving. 4. Gain the knowledge and understanding of the concepts of Linear programming and develop skills of formulating and solving linear programming problems based on real world problems. 5. Attain the cognitive and technical skills required for accomplishing assigned tasks relating to the chosen
CLO 5 is related to practical	

components of the course.	fields of learning in the context of broad multidisciplinary contexts to solve commercial and social real world problems using Mathematics.		
	Theory	Practical	Total
Credits	2	1	3
Contact Hours	2	2	4
Internal Assessment Marks	15	5	20
End Term Examination Marks	35	20	55
Examination Time	3Hrs	3Hrs	

Max. Marks: 75

Part B- Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 7 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Matrices and Determinants: Definition of a matrix, Order, Equality, Types of matrices, Operations on matrices: addition, multiplication and multiplication with a scalar and their simple properties. Minors, Co-factors, Determinant, Properties of determinants and applications of determinants in finding the area of a triangle, Adjoint and inverse of a square matrix, Solutions of simultaneous linear equations.	8

II	Differentiation, Derivatives of simple functions and other functions having applications in business and social studies, Maxima and minima of a function and their applications to Revenue, Cost, Demand, Production, Profit functions and other functions related to commercial and social Problems. Integration of simple functions and its applications in commercial and economic problems.	8
III	Simple interest and compound interest. Annuities: Types of annuities, Present value and amount of an annuity (including the case of continuous compounding), Valuation of simple loans and debentures, Problems related to sinking funds.	8
IV	Linear Programming: Formulation of linear programming problems (LPP) and their solution by graphical and Simplex methods. Applications of linear programming in solving social science and business problems.	8
	Practical	
	The examiner will set 4 questions at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve 2 questions. The evaluation will be done on the basis of practical record, viva-voce and written examination. **Problem Solving**-Questions related to the practical applications based on following problems will be worked out and record of those will be maintained in the Practical Note Book: 1. Problems to find sum of matrices. 2. Problems to find product of matrices.	30

	3. Problems to find determinant of a matrix. 4. Problems to find inverse of a matrix. 5. Problems to find solution of system of linear equations. 6. Problems to find derivatives of simple functions related to commerce and social sciences. 7. Problems to find integration of simple functions related to economic problems. 8. Problems to find maxima of profit function, production, demand function and minima of cost function. 9. Problems to find simple and compound interest. 10. Problems based on annuity. 11. Formulation of real life commercial and social science problems (LPP) related to maximizing profits, minimizing costs, minimal usage of resources etc. and their solutions.	

Suggested Evaluation Methods

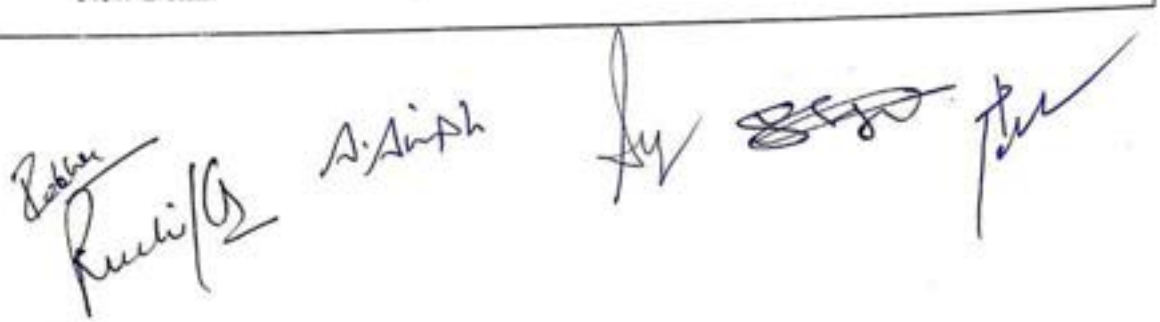
Internal Assessment: ➢ **Theory 15** • Class Participation: 4 • Seminar/presentation/assignment/quiz/class test etc.: 4 • Mid-Term Exam: 7 ➢ **Practicum 5** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 5 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 35** Written Examination ➢ **Practicum 20** Lab record, viva-voce, written examination.

Part C-Learning Resources

Recommended Books:

1. E.T. Dowling(2020). *Schaum outlines of Calculus for Business, Economics and the Social Sciences*. McGraw Hill.
2. S.C. Gupta and V.K. Kapoor (2014). *Fundamentals of Mathematical Statistics*. S. Chand & Sons, Delhi.
3. Seymour Lipschutz and Marc Lars Lipson (2013). *Linear Algebra*. (4th Edition) Schaum's Outline Series, McGraw-Hill.

4. D.C. Sancheti and V.K. Kapoor (2011). *Business Mathematics*. Sultan Chand and Sons.
5. Holden(2010). *Introductory Mathematics for Business and Economics*. Ane/pal Exclusive.
6. E.T. Dowling(2009). *Schaum outlines of Mathematical methods for Business and Economics*. McGraw Hill.
7. E. Don and J. Lerner(2009). *Schaum's outline of Basic Business Mathematics* (2nd Edition). McGraw Hill.
8. L.N.Paul (2002). *Linear Programming: an introductory analysis*. Tata Mcgraw Hill. New Delhi.



ANNEXURE-"X"

CC-3/ MCC-4	
Session: 2024-25	
Part A – Introduction	
Subject	Mathematics
Semester	III
Name of the Course	Differential Equations-1
Course Code	B23-MAT-301
Course Type: (CC/MCC/MDC/CC-M/ DSEC/VOC/DSE/PC/AEC/VAC)	CC
Level of the course	200-299
Pre-requisite for the course (if any)	Mathematics as a subject at 4.0 Level (Class XII)
Course Learning Outcomes(CLOs):	**After completing this course, the learner will be able to:** 1. Gain knowledge of the basic concepts of ordinary differential equations and learn various techniques of finding exact solutions of certain solvable first order differential equations. 2. Have procedural knowledge and cognitive and technical skills of solving homogeneous and non-homogeneous second order linear ordinary differential equations with constant coefficients and with variable coefficients. 3. Gain knowledge of theory of total differential equations and basic concepts of partial differential equations. To learn methods and techniques for solving linear PDEs of first order and to acquire technical skills

	for accomplishing assigned tasks relating to formulation and solution of PDEs in broad multidisciplinary contexts. 4. Have knowledge of concepts and theories of second order PDEs and to apply theory of PDEs to determine integral surfaces through a given curve and to find orthogonal surfaces. To understand compatible systems and to learn cognitive and technical skills required for selecting and using relevant Charpit method, Jacobi method methods to assess the appropriateness of approaches for solving PDEs.
CLO 5 is related to the practical component.	5. To attain cognitive and technical skills required for selecting and using relevant methods and techniques to assess the appropriateness of approaches to solving problems associated with the differential equations. To attain technical skill of solving differential equations by using built in functions of MAXIMA software.

	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Examination Marks	50	20	70
Examination Time	3 Hours	3 Hours	

Max. Marks:100

Part B- Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Basic concepts and genesis of ordinary differential equations, Order and degree of a differential equation, Solutions of differential equations of first order and first degree, Exact differential equations, Integrating factor, First order higher degree equations solvable for x, y and p, Lagrange's equations, Clairaut's form and singular solutions. Orthogonal trajectories of one-parameter families of curves in a plane.	12
II	Solutions of linear ordinary differential equations with constant coefficients, linear non-homogeneous differential equations. Linear differential equation of second order with variable coefficients. Method of reduction of order, method of undetermined coefficients, method of variation of parameters. Cauchy-Euler equation.	12
III	Solution of simultaneous differential equations, total differential equations. Genesis of Partial differential equations (PDE), Concept of linear and non-linear PDEs. Complete solution, general solution and singular solution of a PDE. Linear PDE of first order. Lagrange's method for PDEs of the form: $P(x, y, z)\, p + Q(x, y, z)\, q = R(x, y, z)$, where $p=\partial z/\partial x$ and $q=\partial z/\partial y$.	12
IV	Integral surfaces passing through a given curve. Surfaces orthogonal to a given system of surfaces. Compatible systems of first order equations. Charpit's method, Special types of first order PDEs, Jacobi's method. Second Order Partial Differential Equations with Constant Coefficients.	12

	Practical	
	The practical component of the course has two parts, Problem Solving and Practical's using MAXIMA software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (COs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program. **(A) Problem Solving**- Questions related to the following problems will be solved and record of those will be maintained in the Practical Notebook: 1. Problems solving for differential equations which are reducible to homogeneous. 2. Problems solving for differential equations which are Exact differential equations. 3. Problems solving for linear differential equations with constant coefficient. 4. Problems solving for linear differential equations with variable coefficient. 5. Problems solving for differential equations by method of variation of parameters. 6. Problems solving for differential equations by method of undetermined coefficients. 7. Problems solving for simultaneous differential equations. 8. Problems solving for different PDEs using Lagrange's method. 9. Problems solving for PDEs with Charpit's method and Jacobi's method.	30

(B)The following practicals will be done using MAXIMA software and record of those will be maintained in the practical note book:

1. Solutions of first and second order differential equations.
2. Plotting of family of solutions of differential equations of first, second and third order.
3. Solution of differential equations using method of variation of parameters.
4. Growth and decay model (exponential case only).
5. Lake pollution model (with constant/seasonal flow and pollution concentration).
6. Density-dependent growth model.
7. Predatory-prey model (basic Volterra model, with density dependence, effect of DDT, two prey one predator).
8. To find the solutions Linear differential equations of second order using built in functions of MAXIMA software.
9. To find numerical solution of a first order ODE using plotdf built in function of MAXIMA.
10. To find exact solutions of first and second order ODEs using ode2 and ic1/ic2 built in functions of MAXIMA.
11. To find exact solutions of first and second order ODEs using desolve and atvalue built in functions of MAXIMA.

➢ **Suggested Evaluation Methods**

Internal Assessment:

➢ **Theory 20**

- Class Participation: 5
- Seminar/presentation/assignment/quiz/class test etc.: 5
- Mid-Term Exam: 10

➢ **Practicum 10**

- Class Participation:
- Seminar/Demonstration/Viva-voce/Lab records etc.: 10
- Mid-Term Exam:

End Term Examination:

Theory 50
Written Examination

➢ **Practicum 20**
Lab record, viva-voce, write up and execution of the program

Part C-Learning Resources

Recommended Books:

1. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). J. Wiley & Sons.
2. B. Rai & D. P. Choudhury (2006). *Ordinary Differential Equations - An Introduction*. Narosa Publishing House Pvt. Ltd. New Delhi.
3. Shepley L. Ross (2014). *Differential Equations* (3rd edition). Wiley India Pvt. Ltd.
4. George F. Simmons (2017). *Differential Equations with Applications and Historical Notes* (3rd edition). CRC Press. Taylor & Francis.
5. Ian N. Sneddon (2006). *Elements of Partial Differential Equations*. Dover Publications.

MCC-5

Session: 2024-25	
Part A – Introduction	
Subject	Mathematics
Semester	III
Name of the Course	Groups and rings
Course Code	B23-MAT-302
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	MCC
Level of the course	200-299
Pre-requisite for the course (if any)	Basic Algebra of 100-199 Level
Course Learning Outcomes(CLOs):	**After completing this course, the learner will be able to:** 1. Gain theoretical knowledge of the concept of a group, subgroup, abelian group, cyclic group, normal group, quotient group and have understanding of the results based on these concepts. 2. Have knowledge and understanding of the theory of group homomorphisms, group isomorphisms and group automorphisms. Learn about the permutation groups, permutations, centre of a group and theorems based on these concepts. 3. Gain the deeper knowledge of the concepts of a ring, subring, ideal, integral domain, field of quotient and understanding of the results based on these concepts. 4. Know about Euclidean rings, Polynomial rings and

CLO 5 is related to the practical component.	Unique factorization domain. 5. Attain the deeper knowledge and understanding of groups and rings, their underlying principles and theories, by solving some problems based on them.

	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Examination Marks	50	20	70
Examination Time	3 Hours	3 Hours	

Max. Marks:100

Part B- Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Definition of a group, Elementary properties of groups, Subgroups and subgroup criteria, Cosets, Index of a sub-group, Coset decomposition, Lagrange's theorem and its consequences, Cyclic groups, Normal subgroups, Quotient groups.	12
II	Homomorphisms, Isomophisms, Automorphisms and inner Automorphisms of groups, Automorphisms of cyclic groups, Permutation groups, Even and odd permutations, Alternating groups, Cayley's theorem, Centre of a group.	12

III	Introduction to rings, Subrings, Integral domains and fields, Characteristic of a ring, Ring homomorphism, Ideals: principal, prime and maximal ideals, Quotient ring, Field of quotients of an integral domain.	12
IV	Euclidean rings, Polynomial rings, Polynomials over the rational field, The Eisenstein's criterion, Polynomial rings over commutative rings, Unique factorization domain.	12
	Practical	
	The examiner will set 4 questions at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve 2 questions. The evaluation will be done on the basis of practical record, viva-voce and written examination. **Problem Solving**-Questions related to the practical applications based on following problems will be worked out and record of those will be maintained in the Practical Note Book: 1. Problems to find the order and inverse of the elements of a group. 2. Problems to find the generators of a cyclic group. 3. Problem to find all possible subgroups of a finite group. 4. Problems to verify Lagrange's theorem. 5.Problems to verify Cayley's theorem and theorem of isomorphism. 6. Problems to find index of a group. 7. Problems related to automorphisms of finite or infinite cyclic groups. 8. Problems related to the multiplication of permutations and to write a permutation as the product of transpositions. 9. Problems to find the inverse of a permutation. 10. Problems to determine whether a subset of a ring is an ideal or not. 11. Problems related to maximal and prime ideals. 12. Problems to find the units of a commutative ring with unity. 13. Problems to determine whether a polynomial is irreducible over the field of rational numbers or not. 14. Problem to determine whether an integral domain is Euclidean domain or not. 15. Problem to determine whether an integral domain is unique factorization domain or not.	30
	➢ **Suggested Evaluation Methods**	

Internal Assessment:	End Term Examination:
➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**Theory : 50** Written Examination **Practicum: 20** Lab record, viva-voce, write up and execution of the program

Part C-Learning Resources

Recommended Books:

1. M. Artin (2011). *Abstract Algebra* (2nd Edition). Pearson.
2. V. Sahai and V. Bist (2010). *Algebra* (3rd Edition). Narosa Publishing House.
3. N. Herstein (2008). *Topics in Algebra* (2nd Edition). Wiley India Pvt. Ltd.
4. S. Singh and Q. Zameeruddin (2006). *Modern Algebra* (8th Edition). Vikas Publishing House Pvt. Ltd.
5. John B. Fraleigh (2002). *A First Course in Abstract Algebra* (7th Edition). Pearson.
6. D.A.R. Wallace (1998). *Groups, Rings and Fields*. Springer
7. J. J. Rotman (1995). *An Introduction to the Theory of Groups* (4th Edition). Springer Verlag.

Session: 2024-25	
Part A – Introduction	
Subject	Mathematics
Semester	III
Name of the Course	Mathematics for All
Course Code	B23-MAT-303
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	MDC
Level of the course	100-199
Pre-requisite for the course (if any)	NA
Course Learning Outcomes (CLOs): CLO 5 is related to practical components of the course.	**After completing this course, the learner will be able to:** 1. Gain knowledge of the concepts of sets, Venn diagrams, De-Morgan's laws, basic set operations and apply this factual knowledge to solve daily life mathematical problems which can be formulated in terms of sets. 2. Understand the concept of differentiation as the rate of change of dependent variable with respect to the change in independent variable. Gain knowledge of differentiation of various functions and apply it to the problems of its own discipline and other disciplines for computing the rate of change. 3. Acquire cognitive and technical knowledge about a variety of methods of representation of statistical data and methods of measure of central tendency. Analyze the problem and apply the best measure of central tendency to draw inferences from the available data. 4. Understand the concept of correlation, correlation methods and conclude about the type of correlation for the available data. Comprehend the skills of curve fitting. 5. Attain a range of cognitive and technical skills to differentiate and integrate various functions. Use

	procedural knowledge to solve simple first order differential equations. Have technical and practical skills required for selecting and using suitable methods for data representation and measure of central tendency.		
	Theory	Practical	Total
Credits	2	1	3
Contact Hours	2	2	4
Internal Assessment Marks	15	5	20
End Term Examination Marks	35	20	55
Examination Time	3Hrs	3Hrs	

Max. Marks:75

Part B-Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 7 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	The concept of a set, Types of sets, Operations on sets, Venn diagram, De-Morgan's laws. The concept of a function, Elementary functions and their graphical representation. Solution of simple quadratic and cubic equations.	8
II	The concept of differentiation, differentiation of simple functions, second order differentiation, Maxima and minima of a function, Use of differentiation for solving problems related to real-life situations.	8

III	Presentation of data: Frequency distribution and cumulative frequency distribution, Diagrammatic and graphical presentation of data, Construction of bar, Pie diagrams, Histograms, Frequency polygon, Frequency curve and Ogives. Measures of central tendency: Arithmetic mean, Median, Mode, Geometric mean and Harmonic mean for ungrouped and grouped data.	8
IV	Correlation: Concept and types of correlation, Methods of finding correlation: Scatter diagram, Karl Pearson's coefficients of correlation, Rank correlation. Principle of least square, Fitting of straight line, second degree curve.	8
	Practical	
	The examiner will set 4 questions at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve 2 questions. The evaluation will be done on the basis of practical record, viva-voce and written examination. **Problem Solving-** Questions related to the practical applications based on following problems will be worked out and record of those will be maintained in the Practical	30

Note Book:

1. Problems involving operations on set using Venn diagram.
2. Problem based on De-Morgan's law.
3. Real life problems leading to quadratic equations.
4. Problem involving solution of simple cubic equations.
5. Formulation and solution of realistic problems to solve system of linear equations.
6. Problem to find nth term of A.P. and G.P. Series.
7. Problems to find first and second derivatives of functions.
8. Problems related to application of maxima and minima in real world problems.
9. Representation of data using Bar and pie diagrams.
10. Representation of data using Histogram, Frequency polygon, Frequency curves and Ogives.
11. Problems to compute measures of central tendency.
12. Problem to calculate Karl Pearson's coefficient of correlation.
13. Problem to fit the straight line for the given data.
14. Practical problems involving solution of simple first order differential equations.

Suggested Evaluation Methods

Internal Assessment:

- **Theory 15**
  - Class Participation: 4
  - Seminar/presentation/assignment/quiz/class test etc.: 4
  - Mid-Term Exam: 7
- **Practicum 5**
  - Class Participation:
  - Seminar/Demonstration/Viva-voce/Lab records etc.: 5
  - Mid-Term Exam:

End Term Examination:

- **Theory 35**
  Written Examination
- **Practicum 20**
  Lab record, viva-voce, written examination.

Part C-Learning Resources

Recommended Books:

1. S.C. Gupta and V.K. Kapoor (2014). *Fundamentals of Mathematical Statistics*, S. Chand & Sons, Delhi.
2. R.V. Hogg, J. W. McKean and A. T. Craig (2013). *Introduction to Mathematical Statistics* (7th edition), Pearson Education.
3. J. V. Dyke, J. Rogers and H. Adams (2011). *Fundamentals of Mathematics*, Cengage Learning.
4. A.S. Tussy, R. D. Gustafson and D. Koenig (2010). *Basic Mathematics for College Students*. Brooks Cole.
5. G. Klambauer (1986). *Aspects of calculus*. Springer-Verlag.

CC-4/MCC-6

Session: 2024-25	
Part A – Introduction	
Subject	Mathematics
Semester	IV
Name of the Course	Analytical Geometry & Vector Calculus
Course Code	B23-MAT-401
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC
Level of the course	200-299
Pre-requisite for the course (if any)	Mathematics as a subject at level 4.0 (Class XII)
Course Learning Outcomes(CLOs):	After completing this course, the learner will be able to: 1. Gain knowledge of the concept of different conic sections, their classification and properties. Understand various terms related to conic sections and gain skills to use them in problem solving. 2. Have knowledge of general form of equation of a sphere and attain procedural knowledge required for solving problems related to intersection of spheres, tangent plane and line, orthogonality, length of tangent and co-axial system of spheres. Learn about equations of cones and apply knowledge for problem solving. 3. Have deeper knowledge and understanding of

	cylinder, enveloping cylinder, tangent plane, director sphere, normal, envelope and to make further use thereof. 4. Understand and solve problems related to scalar and vector product of vectors, vector differentiation, directional derivatives, gradient, divergence and curl operators. Have deeper understanding of line, surface and volume integrals, their evaluation, proof of Gauss Divergence, Green's and Stoke's theorems and gain theoretical and technical knowledge in computing different surface flux integrals, volume integrals and line integrals used in other disciplines also. 5. Attain cognitive and technical skills required for formulate and solve real life practical problems on sphere, cone and cylinder; to generate solutions of practical problems involving complex line, surface and volume integral using Gauss Divergence theorem, Stoke's theorem, Green's theorem in a very easy manner.
CLO 5 is related to the practical component of the course.	

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End term Examination Marks	50	20	70

Examination Time	3 Hours	3 Hours	
	Max. Marks:100		

Part B- Contents of the Course

Instructions for Paper- Setter

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	General equation of second degree: Classification of conic sections; centre, asymptotes, axes, eccentricity, foci and directrices of conics. Tangent at any point to a conic, chord of contact, pole of line to a conic, director circle of a conic. Polar equation of a conic, tangent and normal to a conic, confocal conics.	12
II	Sphere: General form, Plane section of a sphere. Sphere through a given circle. Intersection of two spheres, tangent plane and line, polar plane and line, orthogonal spheres, radical plane of two spheres and co-axal system of spheres.	12
III	Cone: Equation of a cone, right circular cone, quadric cone, enveloping cone. Tangent plane and condition of tangency. Cylinder: Right circular cylinder and enveloping cylinder. Central Conicoids: Equation of tangent plane. Director sphere.	12

IV	Scalar and Vector product of three vectors, four vectors, reciprocal vectors, vector differentiation and derivative along a curve, directional derivatives; Gradient of a scalar point function, divergence and curl of vector point functions, their geometrical meanings and vector identities. Vector integration: line integral, surface integral and volume integral. Theorem of Gauss, Green, Stoke and problems based on these.	12
	Practical	
	The examiner will set 4 questions at the time of practical examination asking two questions by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve two problems. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program. **Problem Solving: Questions related to the following problems will be worked out and record of those will be maintained in the Practical Notebook:** 1. Practical problems to find nature of the curve, center and the equation of the conic referred to center as the origin. 2. Practical problems to demonstrate the length of axes, eccentricity and the equations of the conic. 3. Practical problems related to reduction of a general equation to the standard form and to discuss nature of conicoid, when all the characteristics roots of discriminant cubic are different from zero.	30

	4. Formulation and solution of real life situations which uses mathematical knowledge and characteristics of sphere (at least two). 5. Formulation and solution of real life situations which uses mathematical knowledge and characteristics of cone (at least two). 6. Formulation and solution of real life situations which uses mathematical knowledge and characteristics of cylinder (at least two). 7. Practical problems to understand geometrical meanings of gradient, divergence and curl. 8. Practical problems to demonstrate use of vector identities based on gradient, divergence and curl. 9. Practical problems to study applications of Gauss Divergence theorem. 10. Practical problems to study applications of Stoke's theorem. 11. Practical problems to study applications of Green's theorem.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write up and execution of the program

Part C-Learning Resources

Recommended Books:

1. Robert J. T. Bell (2022). *An Elementary Treatise on Coordinate Geometry of Three Dimensions*. Legare Street Press.
2. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). *Thomas' Calculus* (14th edition). Pearson Education.
3. Howard Anton, I. Bivens & Stephen Davis (2016). *Calculus* (11th edition). Wiley India.
4. James Stewart (2012). *Multivariable Calculus* (7th edition). Brooks/Cole Cengage Learning.
5. D. Chatterjee (2009). *Analytical Geometry: Two and Three Dimensions*. Narosa Publishing House.
6. Murray Spiegel and Seymour Lipschutz (2009). *Vector Analysis* (2nd edition). Schaum Outline Series.
7. Shanti Narayan and P.K. Mittal (2007). *Analytical Solid Geometry*. S. Chand and Company.
8. Shanti Narayan and P.K. Mittal (2003). *A Text Book of Vector Calculus*. S. Chand.
9. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith (2002). *Calculus* (3rd edition). Pearson Education.
10. Gordon Fuller and Dalton Tarwater (1992). *Analytic Geometry* (7th edition). Pearson.
11. J.H. Kindle (1990). *Analytic Geometry*. McGraw-Hill
12. Gabriel Klambauer (1986). *Aspects of Calculus*. Springer-Verlag.

MCC-7

Session: 2024-25	
Part A - Introduction	
Subject	Mathematics
Semester	IV
Name of the Course	Linear Algebra
Course Code	B23-MAT-402
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	MCC
Level of the course	200-299
Pre-requisite for the course (if any)	100-199
Course Learning Outcomes(CLOs):	**After completing this course, the learner will be able to:** 1. Have comprehensive knowledge and understanding of the concepts of vector space, subspace, linear span, linearly independence, basis, dimension and quotient space. 2. Gain the procedural knowledge required to find the null space, range space, rank, nullity of linear transformation. Understand the proof of rank-nullity theorem and change of basis concept. 3. Have deeper knowledge of the concept of algebra of linear transformations, dual spaces and bi-dual spaces. Find the eigen values, eigen vectors and minimal polynomials of linear transformations. 4. Gain the theoretical knowledge and understanding of inner product space, Gram Schmidt orthogonalization process and

CLO 5 is related to the practical component.	Bessel's inequality. Attain the cognitive skills to apply the learnt concepts to solve mathematical problems. 5. Attain cognitive and technical skills required for performing and accomplishing complex tasks related to problems of linear algebra. Have technical and practical skills required to solve problems related to linear algebra using built in functions of MAXIMA and other FOSS software.

	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Examination Marks	50	20	70
Examination Time	3 Hours	3 Hours	

Max. Marks:100

Part B- Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Vector spaces: Vector spaces, Subspaces, Linear sum and direct sum of subspaces, Linear span, Linearly independent and dependent subsets of a vector space, Finitely generated vector spaces, Existence theorem for basis of a finitely generated vector space, Invariance of	12

	the number of elements in basis of a finitely generated vector space, Dimension, Quotient space and its dimension.	
II	Homomorphisms : Linear transformations and linear functionals on vector spaces, Matrix of a linear transformation, Null space and range space of a linear transformation, Rank and nullity theorem, Singular and non-singular linear transformation, Change of basis.	12
III	Algebra of linear transformations, Dual spaces, Bi-dual spaces, Annihilator of subspaces of finite dimensional vector space. Eigen values, Eigen vectors, Minimal polynomial and diagonalization of a linear transformation.	12
IV	Inner product spaces: Inner product spaces, Cauchy-Schwarz inequality, Orthogonal sets and basis, Bessel's inequality for finite dimensional vector spaces, Gram-Schmidt orthogonalization process. Adjoint of a linear transformation and its properties, Unitary linear transformations.	12
	Practical	
	The practical component of the course has two parts, Problem Solving and Practical's using MAXIMA/Scilab/SageMath software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program. **(A) Problem Solving**- Questions related to the following problems	30

will be solved and record of those will be maintained in the Practical Notebook:

1. Problems based on Extension theorem.
2. Problems based on Existence theorem.
3. Problems to verify rank and nullity theorem.
4. Problems to find coordinates of a vector relative to an ordered basis.
5. Problems to determine basis and dimension of quotient space of a given finite dimensional vector space.
6. Problems related to change of basis.
7. Problems related to bi-dual spaces.
8. Problems related to the diagonalization of a linear transformation.

(B)The following practicals will be done using MAXIMA/Scilab/SageMath software and record of those will be maintained in the practical note book:

1. Practical problems to determine rank of a matrix associated with linear transformation.
2. Practical problems to determine Nullity of a matrix associated with linear transformation.
3. Practical problems to verify rank-nullity theorem.
4. Practical problems to find null space of matrix associated with linear transformation.
5. To determine eigen values of a matrix associated with linear transformation.
6. To determine normalized eigen vector of a matrix associated with linear transformation.
7. Practical problems related to inner product of vectors or functions.
8. Problems related to Gram-Schmidt orthogonalization process.

➢ **Suggested Evaluation Methods**

Internal Assessment:	**End Term Examination:**
➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10	**Theory: 50** Written Examination **Practicum: 20** Lab record, viva-voce, write up and execution of the program

- Mid-Term Exam:

Part C-Learning Resources

Recommended Books:

1. K. Hoffman and R. Kunze (2015). *Linear Algebra* (2nd edition). Prentice-Hall.
2. I. S. Luther and I. B. S. Passi (2012). *Algebra Vol. –II*. Narosa Publishing House.P. B.
3. V. Sahai and V. Bist (2013). *Linear Algebra* (2nd Edition). Narosa Publishing House.
4. S. Lang (2005). *Introduction to Linear Algebra* (2nd edition). Springer India.
5. P.B. Bhattacharya, S. K. Jain and S. R. Nagpaul (1997). *Basic Abstract Algebra* (Indian Edition). Cambridge University Press.
6. I. N. Herstein (1975). *Topics in Algebra*. Wiley Eastern Ltd. New Delhi.

MCC-8	
Session: 2024-25	
Part A - Introduction	
Subject	Mathematics
Semester	IV
Name of the Course	Differential Equations-II
Course Code	B23-MAT-403
Course Type: (CC/MCC/MDC /CC-M/DSEC/VOC/ DSE/PC / AEC/VAC)	MCC
Level of the course	200-299
Pre-requisite for the course (if any)	Differential Equations-I (B23-MAT-301)
Course Learning Outcomes(CLOs):	**After completing this course, the learner will be able to:** 1. Have the procedural knowledge and cognitive and technical skills of solving second and higher order linear partial differential equations (homogeneous and non-homogeneous). Develop the skills to find the solution of PDEs with variable coefficients. 2. Have deeper knowledge to classify the second order partial differential equations and reduce them in canonical forms, to find characteristic equations and curves. Learn cognitive skill for solving non-linear partial differential equations and their application to solve problems of science and society. 3. Gain theoretical and practical knowledge to solve the Laplace, heat and wave equations. Have technical and cognitive skills to generate solutions for modelling and

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CLO 5 is related to the practical component.	solving real world problems. 4. Gain knowledge and attain skills of solving ordinary and partial differential equations with the help of Laplace transforms and Fourier transforms. 5. Acquire cognitive and technical skills to accomplish complex tasks of solving second order PDEs by analyzing different methods and using available softwares.

	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Exam Marks	50	20	70
Examination time	3 Hours	3 Hours	

Maximum Marks = 100

Part B- Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Integral surfaces passing through a given curve, surfaces orthogonal to a given system of surfaces. Solutions of second and higher order linear partial differential equations (homogeneous and non-homogeneous) with constant coefficients. Solution of PDEs with variable coefficients.	12
II	Classification of linear partial differential equations of second order,	12

	Hyperbolic, parabolic and elliptic types. Reduction of second order linear partial differential equations to Canonical (Normal) forms and their solutions. Characteristic equations and characteristic curves of second order partial differential equation. Monge's method for solving second order partial differential equations. Solution of linear hyperbolic equation.	
III	Method of separation of variables. Laplace's equation: occurrence, elementary solution, families of equipotential surfaces, boundary value problems, separation of variables. Wave equation: occurrence, elementary solution, separation of variables. Diffusion (Heat) equation: occurrence, elementary solution, separation of variables.	12
IV	Basics of Laplace transform and inverse Laplace transform. Solutions of ordinary and partial differential equations using Laplace transforms. Basics of Fourier transform and inverse Fourier transform. Solutions of partial differential equations using Fourier transform.	12
	Practical	
	The practical component of the course has two parts, Problem Solving and Practical's with free and open source software (FOSS) Scilab/MAXIMA/SageMath The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course outcomes (CLOs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of	30

practical record, viva-voce, write up and execution of the program.

(A) Problem Solving-Questions related to the following problems will be solved and record of those will be maintained in the Practical Notebook:

1. Problems of solving homogenous linear partial differential equations of second and higher order.
2. Problems of solving non homogenous linear partial differential equations with constant coefficients.
3. Problems of solving partial differential equations with variable coefficients reducible to equations with constant coefficients.
4. Problems of reducing the second order partial differential equations to canonical form and solve it.
5. Problems of solving second order partial differential equations by Monge's method.
6. Solving problems of Wave, Heat and Laplace equations.
7. Solving ordinary and partial differential equations with the help of Laplace transform.
8. Solving partial differential equations with the help of Fourier transform.

(B)The following practical's will be done using free and open source software (FOSS) Scilab/MAXIMA/SageMath record of those will be maintained in the practical note book:

1. To find the Solutions of second and higher order homogeneous linear partial differential equations.
2. To find the Solutions of second and higher order non-homogeneous linear partial differential equations.

	3. To find characteristic equations of second order partial differential equation. 4. To find the solution of one dimensional Wave equations. 5. To find the solution of two dimensional Wave equations. 6. To find the solution of one dimensional Heat equations. 7. To find the solution of two dimensional Heat equations. 8. To find the solution of Laplace equations. 9. To find the solutions of ordinary and partial differential equations with the help of Laplace transform. 10. Solving partial differential equations with the help of Fourier transform.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write up and execution of the program

Part C-Learning Resources

Recommended Books:

1. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). J. Wiley & Sons.
2. TynMyint-U & Lokenath Debnath (2013). *Linear Partial Differential Equation for Scientists and Engineers* (4th edition). Springer India.
3. H. T. H. Piaggio (2004). *An Elementary Treatise on Differential Equations and Their Applications*. CBS Publishers.
4. S. B. Rao & H. R. Anuradha (1996). *Differential Equations with Applications*. University Press.

5. Ian N. Sneddon (2006). *Elements of Partial Differential Equations.* Dover Publications.
6. Murray R. Spiegel (2005). *Laplace transforms.* Schaum's outline series.
7. Ian N. Sneddon (1974). *The use of Integral transforms.* McGraw Hill.
8. Lokenath Debnath, Dambaru Bhatta (2014). *Integral Transforms and Their Applications* (Third Edition). CRC Press, Boca Raton.

DSE-1	
Session: 2024-25	
Part A – Introduction	
Subject	Mathematics
Semester	IV
Name of the Course	Probability Theory & Statistics
Course Code	B23-MAT-404
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE
Level of the course	200-299
Pre-requisite for the course (if any)	Mathematics as a subject at level 4.0 (Class XII)
Course Learning Outcomes(CLOs):	**After completing this course, the learner will be able to:** 1. Gain the deeper knowledge and understanding of theory of probability, distribution function, probability density functions and joint probability distribution function and learn to use those for problem solving. Attain the cognitive skills to use Baye's theorem to solve realistic models. 2. Have the knowledge of the concepts of mathematical expectation, moments, moment generating function uniform, binomial, geometric and Poisson distributions and attain the skills required for choosing statistical tool to solve real life problem. 3. Gain the knowledge of the concepts of uniform, normal, beta,

	gamma, Cauchy, lognormal, Laplace distributions and their applications in real life statistical models. 4. Gain the procedural knowledge to find correlation coefficient, covariance, linear regression and to solve problems by method of least squares. Acquire the skills required to apply studied statistical methods in investigation and solution of real based statistical models.
CLO 5 is related to the practical component.	5. Attain cognitive and technical skills required for performing and accomplishing complex tasks relating to realistic statistical models. To attain technical skills to demonstrate measures of central tendency and dispersion, rank correlation, fitting of different distributions using built in functions of SPSS/ Excel software.

	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Examination Marks	50	20	70
Examination Time	3Hours	3Hours	

Max. Marks: 100

Part B- Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours

I	Basic notions of probability, Conditional probability and independence, Baye's theorem. Random variables: Discrete and continuous, Cumulative distribution function (c.d.f.), Probability mass function (p.m.f.), Probability density functions (p.d.f.), Illustrations and properties of random variables, univariate transformations with illustrations. Two dimensional random variables: Discrete and continuous, Joint, Marginal and conditional c.d.f., p.d.f., p.m.f, independence of variables, bivariate transformations with illustrations	12
II	Mathematical expectation, Moments, Moment generating function, Joint moment generating function, Characteristic function. Discrete probability distributions: Uniform, Binomial, Negative binomial, Geometric and Poisson.	12
III	Continuous probability distributions: Uniform, Normal, Beta, Gamma, Cauchy, Exponential, lognormal and Laplace distribution, properties and limiting/approximation cases.	12
IV	The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Linear regression, The method of least squares, Fitting of curves, Exponential curves.	12
	Practical	
	The practical component of the course has two parts, Problem Solving and Practical's using SPSS/Excel software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes	30

(CLOs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.

Problem Solving-Questions related to the practical applications based on following problems will be worked out and record of those will be maintained in the Practical Note Book:

1. Problems based on conditional probability.
2. Problems based on Bayes' Theorem.
3. Problems based on probability density function.
4. Problems based on joint probability distribution function of random variables.
5. Problems to find marginal probability distribution and conditional probability distribution function of random variables.
6. Problems to compute Karl Pearson's coefficient of correlation for given bivariate frequency distribution.
7. Problems to find Spearman's rank correlation coefficient for given data.
8. Problems related to realistic models involving binomial distribution.
9. Application based problems involving Poisson distribution.
10. Problems involving normal distribution to solve real life models.
11. Problem solving related to expectation and moment of random variables.

	(B) The following practicals will be done using SPSS/ Excel software and record of those will be maintained in the practical note book: 1. Problems related to measures of central tendency. 2. Problems related to measures of dispersion. 3. Fitting of binomial distribution. 4. Fitting of Poisson distribution. 5. Fitting of normal distribution. 6. Fitting of lines of regression. 7. Fitting of curves by least square method. 8. Regression analysis. 9. Practical problems related to correlation coefficients and rank correlation.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, written examination.

Part C-Learning Resources

Recommended Books:

1. S.C. Gupta and V.K. Kapoor (2020). *Fundamentals of Mathematical Statistics*. Sultan Chand & Sons.
2. S.P. Gupta (2019). *Statistical Methods*. Sultan Chand & Sons.
3. N.G. Das (2017). *Statistical Methods*. McGraw Hill Education.
4. I. Miller and M. Miller (2014). *John E. Freund's Mathematical Statistics with Applications* (8th edition). Pearson. Dorling Kindersley Pvt. Ltd. India.
5. S. M. Ross (2014). *Introduction to Probability Models* (11th edition). Elsevier.
6. R. V. Hogg, J. W. McKean and A. T. Craig (2013). *Introduction to Mathematical Statistics* (7th

Edition). Pearson Education.
7. S. David (2003). *Elementary Probability* (2nd Edition). Cambridge University Press.
8. Jim Pitman (1993). *Probability*, Springer-Verlag.

DSE-1	
Session: 2024-25	
Part A – Introduction	
Subject	Mathematics
Semester	IV
Name of the Course	Special Functions
Course Code	B23-MAT-405
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE
Level of the course	200-299
Pre-requisite for the course (if any)	Calculus and Differential Equations of level 100-199
Course Learning Outcomes (CLOs):	**After completing this course, the learner will be able to:** 1. Gain the knowledge and understanding of singular points of differential equations and learn to solve the equations, having singular points, by Power series method. Have deeper knowledge about Hypergeometric differential equation, Hypergeometric function and its properties and the procedure of solving Hypergeometric differential equation. 2. Have the knowledge about the concepts of Bessel's differential equation and learn procedure to find its solutions of different kind. Acquire deeper knowledge of recurrence relations, generating function, orthogonality and integral of Bessel's functions. Attain skills to make use of

	Bessel functions in scientific problem solving. 3. Gain the deeper knowledge of Legendre's differential equation and learn procedure to find its solution in the form of Legendre functions. Understand the concepts of recurrence relations, generating function, orthogonality of Legendre's function and Rodrigues' formula. Acquire the skills to solve mathematical and scientific problems involving Legendre's equation. 4. Have the knowledge of theoretical concepts of Hermite's differential equation and procedural knowledge to find its solution in the form of Hermite functions. Understand facts and theory about recurrence relations, generating function and othogonality of Hermite function, Rodrigues' formula. Acquire the skills to use Hermite function for solving mathematical and scientific problems. 5. Attain the cognitive and technical skills required for performing and accomplishing complex tasks related to series solution of differential equations, Hypergeometric, Bessel's, Legendre's and Hermite's differential equations. Acquire analytical and numerical skills to solve mathematical and scientific problems involving these differential equations and the special functions.
CLO 5 is related to the practical component.	

	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30

End Term Exam Marks	50	20	70
Examination Time	3Hrs	3Hrs	

Max. Marks: 100

Part B-Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Series solution of differential equations: Power series method, Hypergeometric Series, Hypergeometric function and its integral representation, Hypergeometric differential equation and solutions, Contiguous function relations, Simple transformations.	12
II	Bessel equation and its solution, Bessel functions and their properties, Convergence, Recurrence relations and generating functions, Bessel's integral, Orthogonality of Bessel functions.	12
III	Legendre differential equation and its solution, Legendre functions and their properties, Recurrence relations and generating functions, Orthogonality of Legendre polynomials, Rodrigues' formula for Legendre polynomials, Laplace integral representation of Legendre polynomial.	12
IV	Hermite differential equation and its solutions, Hermite function and its properties, Recurrence relations and generating functions, Orthogonality of Hermite polynomials, Rodrigues' formula for Hermite Polynomial.	12

Practical

The practical component of the course has two parts, Problem Solving and Practicals using MAXIMA/Scilab/MATLAB software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.

(A) Problem Solving- Questions related to the following problems will be solved and record of those will be maintained in the Practical Notebook:

1. Problems solving for ordinary differential equations using Frobenius method.
2. Problems based on Hypergeometric differential equation.
3. Problems involving Bessel's differential equation.
4. Problems related to Legendre differential equation.
5. Problems to find solution of Hermite differential equation.
6. Problems based on recurrence relations and generating functions of Bessel's function.
7. Problems based on recurrence relations and generating functions of Legendre's polynomial.
8. Problems based on recurrence relations and generating functions of Legendre's polynomial.

(B)The following practicals will be done using MATLAB/ SCILAB/MAXIMA software and record of those will be maintained in the practical note book:

1. Practical problems for plotting of the Bessel's functions of first kind of order 0 to 3

	2. Practical problems to find zeros of Bessel's function of first and second kind. 3. Practical problems to find zeros of first derivative of Bessel function of first kind and Legendre's polynomial. 4. Practical problems for plotting of Legendre polynomial for n=1 to 5 in the interval [0,1] and verifying graphically that all roots of Legendre polynomial lies in the interval [0,1]. 5. Practical problems related to coefficients of Legendre polynomial. 6. Practical problems based on plotting of Hermite polynomial. 7. Practical problems related to realistic models involving Bessel differential equation and their solutions. 8. Practical problems related to realistic models involving Legendre's differential equations and their solutions.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write up and execution of the program

Part C-Learning Resources

Recommended Books:

1. E. Kreyszig (2011). *Advanced Engineering Mathematics* (10th Edition). Wiley.
2. S. L. Ross (2007). *Differential Equations* (3rd Edition). Wiley India.
3. W.W. Bell (2004). *Special Functions for Scientists and Engineers.* Dover Books on Mathematics.
4. L.C. Andrews (1992). *Special Functions of Mathematics for Engineers.* Oxford University Press and SPIE Press.

5. E. D. Ranville (1960). *Special Functions*. Macmillan.
6. George E. Andrews, Richard Askey, Ranjan Roy (1999). *Special Functions*. Cambridge University Press.

VAC-3

Session: 2024-25	
Part A- Introduction	
Subject	Mathematics
Semester	III
Name of the Course	Mathematics in India: From Vedic Period to Modern Times
Course Code	B23-VAC-308
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	VAC
Level of the course	100-199
Pre-requisite for the course (if any)	NA
Course Learning Outcomes (CLOs):	**After completing this course, the learner will be able to:** 1. Have knowledge about the development of mathematical ideas and techniques in Indian mathematics during Vedic and Ancient period. Attain sufficient level of the historical background and contributions of notable Indian mathematicians to explore Indian knowledge system further. 2. Have deeper knowledge about development of mathematics during the Medieval period. Theoretical knowledge used in various branches of mathematics like techniques of calculus and spherical trigonometry found in the Kerala school of astronomy and mathematics will be gained. Learn about the biography and contributions of eminent Indian mathematicians during this period and Indian knowledge system as such. 3. Gain knowledge about development of mathematics in modern period. Have knowledge of notable work of Srinivasa Ramanujan and other mathematicians with other aspects of the old and strong traditions of mathematics in India. Familiarize with biographies of Mathematicians in modern period.

	4. Have Knowledge about the prestigious Fields Medal, Abel Prize in the subject of mathematics and their significance. Gain theoretical knowledge about illustrious contributions of contemporary Indian mathematicians.		
	Theory	Practical	Total
Credits	02	-	02
Contact Hours	02	-	02
Internal Assessment Marks	15	-	15
End Term Examination Marks	35	-	35
Examination Time	3 Hours	-	

Max. Marks: 50

Part B- Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 7 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	**Ancient Period**: Development of Indian mathematics during Vedic and Ancient period. Overview of the Vedic period, Mathematical ideas in the Vedas and manuscripts in Indian mathematics. Life, background, notable works, mathematical contribution of Baudhayana, Pingala, Aryabhata, Brahmagupta, Bhaskaracharya, Mahaviracharya and Lilavati.	8
II	**Medieval Period**: Kerala School of Mathematics, Madhava of Sangamagrama, Nilakantha Somayaji, Jyesthadeva: Overview of historical backgrounds and their contribution.	8
III	**Modern Period:** Srinivasa Ramanujan, Satyendra Nath Bose, Radhanath Sikdar, P.C. Mahalanobis, D.R. Kaprekar: Early life, Education, Challenges, Achievements and their contribution.	8

IV	**Medals and Prizes in Mathematics and Contemporary Mathematicians:** Introduction to the prestigious Fields Medal, Abel Prize and their significance. Biography and contributions of illustrious mathematicians from India: Subrahmanyan Chandrasekhar, C.R. Rao, S.R. Srinivasa Varadhan, Manjul Bhargava, Akshay Venkatesh, Harish-Chandra and Shakuntala Devi.	8

Suggested Evaluation Methods

Internal Assessment:	**End Term Examination:**
➢ **Theory 15** Class Participation: 4 Seminar/presentation/assignment/quiz/class test etc.: 4 Mid-Term Exam: 7	➢ **Theory 35** Written examination

Part C-Learning Resources

Recommended Books:

1. C. N. Srinivasiengar (1967). *History of Mathematics in India.* The World Press Pvt. Ltd., Calcutta.
2. A.K. Bag (1979). *A Cultural History of Mathematics in Ancient India.* Chaukhamba Orientalia, Varanasi.
3. George Gheverghese Joseph (2016). *Indian Mathematics: Engaging with the World from Ancient to Modern Times*. World Scientific.
4. T.A. Sarasvati Amma (2007). *Geometry in Ancient and Medieval India*. Motilal Banarsidass Publishers Limited
5. S. Balachandra Rao (1998). *Indian Mathematics and Astronomy: Some Landmarks*. Jnana Deep Publications
6. John Stillwell (2010). *Mathematics and its History*. Springer (Includes a section on Indian mathematics)
7. Ramakalyani V. Sita Sunder Ram (2021). *History and development of Mathematics in India*. National mission for Mathematics and DK Printworld (P) Ltd, New Delhi.
8. Gerard G. Emch (2005). *Contribution to the history of Indian Mathematics.* Hindustan Book Agency.
9. R. B. Singh (2008). *Origin and development of Mathematics*. Vista International Publishing House, New Delhi.

VAC-4

Session: 2024-25

Part A – Introduction

Subject	MATHEMATICS
Semester	IV
Name of the Course	MATHEMATICS IN EVERYDAY LIFE
Course Code	B23-VAC-418
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	VAC
Level of the course	100-199
Pre-requisite for the course (if any)	NA
Course Learning Outcomes(CLOs):	**After completing this course, the learner will be able to:** 1. Gain knowledge of facts, concepts and rules to calculate simple and compound interests. Understand the technical terms related to income tax and Equated monthly installment (EMI) and then to apply their enhanced technical and analytical skills to calculate income tax for different level of income tax payee and aware about how much they have to pay each month on a loan. They will be able to compare the results and discuss the impact of compounding on long term savings. 2. Have deeper knowledge of profit, loss, work, time and distance, coding and decoding inculcate technical and cognitive skill in solving problems related to these. Attain procedural skill to solve real life problems related to ratios

	and proportions. Gain procedural and technical knowledge to solve the practical problems of height and distances using concepts of trigonometry. 3. Attain technical and cognitive skills to analyze and solve numerical based on the concept of sequence and series, Arithmetic Progression, Geometric Progression, permutation and combination. 4. Develop cognitive skill to analyze the results of a sample using measures of central tendency and graphical representation (pie charts, frequency polygons, ogive). To design and conduct a survey on a relevant topic of their choice (e.g., favorite leisure activities, dietary habits, etc.). Have procedural knowledge to solve linear programming problems used in everyday life.	
Credits	Theory	Practical	Total
	2	-	2
Contact Hours	2	-	2
Internal Assessment Marks	15	-	15
End Term Exam Marks	35	-	35
Examination time	3 Hours		3 Hours

Part B- Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 7 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

Unit	Topics	Contact Hours
I	Simple interest, Compound interest, Equated monthly installment (EMI), Direct tax calculation.	8
II	Profit and loss, Work, time and distance, Coding and Decoding, Ratio and proportion, Trigonometry and its applications, Mensuration for practical purposes.	8
III	Sequence and series, Arithmetic progression, Geometric progression, Permutation and combinations (simple problems).	8
IV	Mean, Mode, Median, Standard deviation, Variance. Bar graphs, Pie charts, Frequency polygons, Ogive. Linear equation in two variables. Linear programming problems (LPP): Graphical solution.	8

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory 15** • Class Participation: 4 • Seminar/presentation/assignment/quiz/class test etc.: 4 • Mid-Term Exam: 7	**End Term Examination:** **Theory 35** Written examination

Part C-Learning Resources

Recommended Books:

1. R. S. Aggarwal (2022). *Quantitative Aptitude.* S Chand & Company Limited, New Delhi.
2. Jaikishan & Premkishan (2022). *How to Crack Test of Reasoning in All Competitive Exams.* Arihant Publications.
3. A. Guha (2020). *Quantitative Aptitude* (7th Edition). Mc Graw Hill Publications.
4. R. V. Praveen (2016). *Quantitative Aptitude and Reasoning* (3rd Edition). PHI publications.
5. R.S. Aggarwal (2018). *A Modern Approach to Logical Reasoning* . S. Chand.
6. Richa Agarwal (2019). *How to Crack Test of Arithmetic.* Arihant Publications.

SEC-3			
Session: 2024-25			
Part A–Introduction			
Subject	Mathematics		
Semester	III		
Name of the Course	Calculation Skills with Vedic Mathematics-II		
Course Code	B23-SEC-303		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	SEC		
Level of the course	100-199		
Pre-requisite for the course (if any)	NA		
Course Learning Outcomes(CLOs): CLO 5 is related to the practical components of the course.	**After completing this course, the learner will be able to:** 1. Gain the knowledge to perform multiplication, division, HCF, LCM and factorization of polynomials using Vedic Sutras. 2. Have the procedural knowledge to apply Vedic sutras to solve linear equations, quadratic equations and simultaneous equations. 3. Have the knowledge and understanding of the concepts of Vedic Geometry and Trigonometry. 4. Attains the cognitive and technical skills to use Vedic sutras and upsutras for solving Algebra, Calculus and Geometry problems with speed and accuracy.		
	Theory	Practical	Total
Credits	2	1	3

Contact Hours	2	2	4
Internal Assessment Marks	15	5	20
End Term Examination Marks	35	15	55
Examination Time	3Hrs	3Hrs	

Max. Marks:75

Part B-Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 7 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Multiplication (Quadratic expressions of single variable), Urdhwatirygbhyaam Method, Combined Operations. Division and Factorization: Division (Divisor: Linear expression of single variable), Factorization (Quadratic and cubic polynomials of two variables) , Factorization of quadratic polynomial containing more than two variables.	8
II	Solution of Simple Equation, solution of linear equation in one variable, solution of linear equations in two variables, solution of quadratic equations, Solution of simultaneous equations.	8
III	LCM and HCF of polynomials. Concept of Baudhayana Number (BN), BN of an angle, Multiplication of a constant in a BN, BN of complementary angles, BN of sum and difference ($\alpha \pm \beta$) of an angle, BN of halfangle.	8

IV	Pythagorean triple, Trigonometric relation for half, twice and thrice of angle, sum, difference of angles using triples Vedic Geometry: Angle between two lines, perpendicular distance of line from a point.	8

	Practical	
	The examiner will set 4 questions at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve 2 questions. The evaluation will be done on the basis of practical record, viva-voce and written examination. **Problem Solving**-Questions related to the following problems will be solved and record of those will be maintained in the Practical Note Book: 1. Multiplication of algebraic polynomials. 2. Division of two polynomials. 3. Factorization of quadratic and cubic polynomials intwo or more than two variables. 4. LCM and HCF of algebraic expressions. 5. Solution of linear equations of one and twovariables. 6. Solution of quadratic equations. 7. Solution of simultaneous equations. 8. Trigonometric relation for twice of angle. 9. Trigonometric relation for thrice of angle. 10. Sum and difference of angles using triples 11. Angle between two straight lines. 12. Perpendicular Distance of line from a point.	30
	Suggested Evaluation Methods	

Internal Assessment:	End Term Examination:
➢ **Theory 15** • Class Participation: 4 • Seminar/presentation/assignment/quiz/class test etc.: 4 • Mid-Term Exam: 7 ➢ **Practicum 5** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 5 • Mid-Term Exam:	➢ **Theory** 35 Written Examination ➢ **Practicum** 15 Lab record, viva-voce, written examination.

Part C-Learning Resources

Recommended Books:

1. U. S. Patankar and S. M. Patankar (2018). *Elements of Vedic Mathematics.* TTU Press.
2. V.Singhal (2014).*Vedic Mathematics for all ages.* Motilal Banarsidas Publishers.
3. R.K.Thakur (2013).*The Essentials of Vedic Mathematics.* Rupa Publications. New Delhi.
4. P. Tiwari and V.K. Pandey (2012). *Vedic Mathematics - Modern Research Methods.* Campus Books International.
5. S. K. Kapoor (2006).*Vedic Geometry Course.* Lotus Press.
6. A. Gupta (2004). *Power of Vedic Mathematics with Trigonometry.* Jaico Publishing House.
7. S.B.K. Krishna Trithaji(1990). *Vedic Mathematics.* Motilal Banarsidas, New Delhi.

Session: 2024-25	
Part A – Introduction	
Subject	Mathematics
Semester	III
Name of the Course	Learning MATLAB Skills
Course Code	B23-SEC-324
CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	SEC
Level of the course	200-299
Pre-requisite for the course (if any)	NA
Course Learning Outcomes(CLOs):	After completing this course, the learner will be able to: 1. Gain theoretical knowledge about memory and file management, basic flow controls, MATLAB program development environment that will help to develop programming skills and techniques to solve problems. 2. Have procedural and technical knowledge required for matrix generation, MATLAB, graphic features and its applications. 3. Gain procedural knowledge of MATLAB in

CLO 5 is related to the practical component of the course.	providing skill for solving polynomial, algebraic and transcendental equations, system of linear equations, ordinary differential equations used in interdisciplinary fields. 4. Have knowledge of tools in MATLAB used for numerical differentiation, numerical integration and to learn cognitive and technical skills required for application of these in analysis of various economical, commercial, and statistical problems. 5. Develop cognitive and technical skills to use MATLAB tools in solving various data handling problems related with multidisciplinary subjects and bridge the skill gap. Learn tools and built in functions of MATLAB/Scilab in solving stated problems. Learn technical skills and understand how to analyze all the results graphically in a very easy manner.

Credits	Theory	Practical	Total
	2	1	3
Contact Hours	2	2	4
Internal Assessment Marks	15	5	20
End term Examination Marks	35	20	55
Examination Time	3 Hours	3 Hours	

Max. Marks:75

Part B - Contents of the Course

Instructions for Paper-Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 7 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Introduction, starting and quitting a MATLAB session, Desktop tools and development environment: command window, command history window, work space current directory, edit window, figure window, help feature. Types of files, Platform dependence, Search path. Control flow and operators, Hierarchy of operations, built in functions, Round off functions, controlling command window input and output.	8
II	Matrix generation, Array operations: Matrix arithmetic operations, Array arithmetic operations, transposing a matrix, reshaping matrices, concatenating a matrix, special matrices viz. eye, zeros, ones, rand, randn, diag, diag etc., vector generation using linspace, logspace.	8
III	Basic plotting: creating simple plots, adding title, axis label, and annotations, multiple data in one plot, specifying line style and colors, figure tools, plot editing mode, using function to edit graphs, modify the graph to enhance the presentation, multiple plots in one figure, visualizing functions of two variables: mesh and surface plots.	8

IV	Polynomials, entering a polynomial, polynomial evaluation, roots of polynomial, polynomial arithmetic, polynomial integration (using MATLAB command), polynomial differentiation (using MATLAB command), Evaluation of polynomials.	8

	Practical	
	The examiner will set 4 questions at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve two problems. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program. **The following practicals will be done using MATLAB/ SCILAB software and record of those will be maintained in the practical note book:** 1. Practical to demonstrate components in MATLAB/SCILAB environment. 2. Practical to demonstrate tool boxes in MATLAB/SCILAB environment. 3. Practical to demonstrate windows in MATLAB/SCILAB. 4. Program to generate odd/even numbers. 5. Practical to demonstrate basic matrix operations (addition, subtraction, multiplication, transpose, determinant, concatenation etc.). 6. Practical to find inverse of a matrix using built-in function. 7. Practical to find roots of an equation using built-in function. 8. Practical to add title, axis labels, line style, color, annotations etc. to a figure/graph. 9. Practical to demonstrate integration and differentiationscommands. 10. Practical problems for solving differential equations. 11. Practical to demonstrate integration and differentiations commands. 12 Practical Problems for solving differential equations.	30

Suggested Evaluation Methods	
Internal Assessment: ➢ **Theory 15** • Class Participation: 4 • Seminar/presentation/assignment/quiz/class test etc.: 4 • Mid-Term Exam: 7 ➢ **Practicum 5** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 5 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 35** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write up and execution of the program

Part C-Learning Resources

Recommended Books:

1. Stephan J. Chapman (2020). *MATLAB Programming for Engineers* (6th edition). Cengage Learning.
2. William Palm Lii (2017). *A concise introduction to MATLAB* (2nd edition). Tata Mcgraw-Hill Education.
3. R.S.Gupta (2015). *Elements of Numerical Analysis* (2nd edition). Cambridge University Press.
4. Steven C. Chapra (2011). *Applied Numerical Methods W/ MATLAB* (3rd edition).Tata Mcgraw-Hill Education.
5. Rudra Pratap (2010). *Getting Started with MATLAB:A quick introduction for scientists and engineers.* Oxford University Press.
6. R. K. Bansal, A. K. Goel, M. K. Sharma (2009). *MATLAB and Its applications in Engineering*. Pearson Education India.
7. Dolores Etter (2008). *Introduction to MATLAB 7, 1e* (1st edition). Pearson Education India.
8. Marc E. Herniter (2000). *Programming in MATLAB* (1st edition). Cengage Learning.

SEC-3

Session: 2024-25

Part A – Introduction

Subject	Mathematics
Semester	III
Name of the Course	Quantitative Aptitude
Course Code	B23-SEC-326
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	SEC
Level of the course	200-299
Pre-requisite for the course (if any)	NA
Course Learning Outcomes(CLOs): CLO 5 is related to the practical component.	**After completing this course, the learner will be ableto:** 1. Comprehend the formulation of equations for specific mathematical problems and use mathematical skills to solve those. 2. Acquire the procedural knowledge to analyze and solve problems related to trains, boats and streams and apply those in real life situations. 3. To get deeper knowledge and understanding of concepts of Simple interest, Compound Interest, Partnership and use this procedural knowledge to perform assigned tasks of solving suchproblems. 4. Familiarize and get acquainted with various measures of central tendency and using cognitive skills to choose better of these for the available data and draw the inferences/results. 5. Attain a range of cognitive and technical skills to analyze and comprehend various numerical concepts, e.g., Formulation of equations, S.I. & C.I., Set theory etc. and apply these learned skills and techniques to solve daily life mathematical problems

	accurately, logically and well in time.		
Credits	Theory	Practical	Total
	2	1	3
Contact Hours	2	2	4
Internal Assessment Marks	15	5	20
End Term Examination Marks	35	20	55
Examination Time	3 Hours	3 Hours	

Max. Marks: 75

Part B- Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsor question by taking course learning outcomes (CLOs) into consideration. The compulsory questio (Question No. 1) will contain 7 parts covering entire syllabus. The examinee will be required t attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Linear Equations, Quadratic equations, System of algebraic equations in two variables and their applications in simple problems.	8
II	Time and distance: Problems based on trains, Boats and Streams, Pipes and Cistern.	8
III	Simple interest, Compound Interest, Partnership. Basic idea of set theory to solve practical problems.	8
IV	Basic idea of Permutations and Combinations. Events and sample space, Probability. Data interpretation: Raw and grouped data, Bar Graph, Pie Chart, Mean, Median and Mode.	8

	Practical	
	The examiner will set 4 questions at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve 2 questions. The evaluation will be done on the basis of practical record, viva-voce, written examination. **Problem Solving-** Questions related to the following problems will be solved and their record will be maintained in the Practical Notebook: 1. To solve problems related to clocks. 2. To write the date of birth of your family members and determine the day of their birth. 3. Compare the simple interest and compound interest for a given amount deposited for fixed time at a fixed rate. 4. Problems related to upstream and downstream of boat. 5. Write down the sample space for tossing three coins one by one and determine the probabilities of occurrence of all possibilities of heads. 6. Problems related to partnership. 7. Draw Venn Diagram for the following (i)Union of sets (ii) Intersection of sets (iii)Difference of sets (iv) Symmetric difference (iv) Complement of a set. 8. Draw a bar-graph for the percentage of expenditure occurred on miscellaneous heads (atleast 5 items) for your family income and write your observation in respect of bar-	30

graph.

9. Draw a pie-chart by taking data of problem (8).

10. Taking the annual export data for three companies for last six years , draw a line- graph.

11. Write atleast two different practical problems related to set theory and solve them with the help of venn-diagram/formula.

12. Problem solving related to pipes and cisterns.

13. Problem solving related to determination of time taken by two trains of given lengths, to cross each other, when their speeds are given.

14. Problem solving related to permutation and combination.

15. Problems involving formulation and solution of quadratic equations in one variable.

16. Formulation and solution of realistic problems to solve system of linear equations.

17. Draw the following:

(i) linear equation $x = a$

(ii)) linear equation $y = a$

(iii) linear equation $a x + b y = c$.

18. Draw a graph for system of equations $a x + by = c$; $d x + e y = f$ (a, b, c, d are real numbers) taking suitable values for a, b, c, d , e, f and depict the

(i)Unique Solution

(ii) No Solution

(iii) Infinitely many solution.

Also state the condition for general system $a x + by = c$; $d x + e y = f$ to have all three possibilities for solution (Unique Solution, No Solution &Infinitely many solution).

Suggested Evaluation Methods	
Internal Assessment: ➢ **Theory 15** • Class Participation: 4 • Seminar/presentation/assignment/quiz/class test etc.: 4 • Mid-Term Exam: 7 ➢ **Practicum 5** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc. 5	**End Term Examination:** ➢ **Theory** 35 Written Examination ➢ **Practicum** 20 Lab record, viva-voce, write up.

Part C-Learning Resources

Recommended Books:

1. R. S. Aggarwal (2022). *Quantitative Aptitude*. S Chand & Company Limited, New Delhi.
2. A. Guha (2020). *Quantitative Aptitude* (7th Edition). Mc Graw Hill Publications.
3. V. Dyke, J. Rogers and H. Adams (2011). *Fundamentals of Mathematics*, Cengage Learning.
4. A.S. Tussy, R. D. Gustafson and D. Koenig (2010). *Basic Mathematics for College Students*. Brooks Cole.
5. C. C. Pinter (2014). *A Book of Set Theory*. Dover Publications.
6. G. Klambauer (1986). *Aspects of calculus*. Springer-Verlag.

Session: 2023-24(Scheme), 2025-26(Syllabus)	
Part A – Introduction	
Subject	Mathematics
Semester	V
Name of the Course	Sequences and Series
Course Code	B23-MAT-501
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC/MCC
Level of the course	300-399
Pre-requisite for the course (ifany)	
CourseLearningOutcomes(CLO):	**After completing this course, the learner will be able to**: 1. Understand basic concepts of real number system, set theory and preliminary results on neighbourhood of a point, interior and limit points, open sets, closed sets etc. 2. Learn about denumerability of subsets of real numbers, sequences, their limits, boundedness and convergence. Determine the convergence and divergence of a sequence. Understand Cauchy sequence and Cauchy general principle of convergence of sequence. 3. Attain skills to determine convergence of a series of real numbers by applying various tests. 4. To know absolute and conditional convergence of alternating series and apply theory to check the convergence of arbitrary series.
CLO 5 is related to the practical component of the course.	5*Attain cognitive and technical skill required to check the convergence of sequences and infinite series and verify the same by applying various available tests and tools.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Examination Marks	50	20	70
Examination Time	3 Hours	3 Hours	

Max. Marks:100

PartB-Contentsofthe Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

Unit	Topics	Contact Hours
I	Boundedness of the set of real numbers, Least upper bound and Greatest lower bound of a set. Archimedean, algebraic and ordered properties in □. The real number system as a complete ordered field. Neighbourhoods, interior points, isolated points, limit points, Open sets, closed sets, interior of a set, closure of a set in real numbers and their properties. Bolzano-Weierstrass theorem. Open covers, compact sets and Heine-Borel theorem.	12
II	Denumerable and non-denumerable sets, Denumerability of integers, rationals and non-denumerability of real numbers. Sequences: Real sequences and their convergence, Theorems on limit of sequence, Bounded and monotonic sequences, Cauchy's sequence, Cauchy general principle of convergence, Subsequences and subsequential limits, Limit superior and limit inferior.	12
III	Infinite series: Convergence and divergence of Infinite Series, Comparison tests of positive terms infinite series, Cauchy's general principle of Convergence of series, Convergence and divergence of geometric series, Hyper Harmonic series or p-series, D-Alembert's ratio test, Raabe's test, Logarithmic test, Cauchy's nth root test, De-Morgan and Bertrand's test, Gauss	12

	Test, Cauchy's integral test, Cauchy's condensation test.	
IV	Alternating series, Absolute and conditional convergence, Leibnitz test. Arbitrary series, Abel's and Dirichlet's test, Insertion and removal of parenthesis, Re-arrangement of terms in a series, Riemann's re-arrangement theorem and Pringsheim's theorem (statement only). Cauchy product of series (definitions and examples only).	12
	Practical	
	The practical component of the course has two parts, Problem Solving and Practical's using Mathematica/ Matlab/Maple/Scilab/ Maxima etc. software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program. **(A) Problem Solving-** Questions related to the following problems will be solved and their record will be maintained in the Practical Notebook: 1. Problem demonstrating that the set of rational numbers is not order complete. 2. Practical problems on finding lub and glb of a set. 3. Problem solving to find limit point of a set using Bolzano Weierstrass Theorem. 4. Problems solving using monotone convergence theorem. 5. Practical problems demonstrating the use of Cauchy's first	30

and second theorems for convergence of sequences.

6. Problem solving on limit inferior and limit superior of a sequence.
7. Practical problems on convergence/divergence of positive term series demonstrating the application of various convergence tests.
8. Problem solving on
   (a) conditional convergence and
   (b) absolute convergence of an alternating series.
9. Practical problems to demonstrate
10. Cauchy product of two convergent series need not be convergent.
11. Cauchy product of two divergent series need not be divergent.
12. Practical problems demonstrating the denumerability of the cartesian product of denumerable sets.
13. Demonstrate the non-denumerability of the set of irrationals.

(B) The following practicals will be done using Mathematica/ Matlab/Maple/Scilab/ Maxima etc.software and also verify results by applying various convergence tests. Their record will be maintained in the practical note book:

1. Testing the convergence of infinite series of positive terms by the use of sequence of partial sums.
2. Testing the convergence of an infinite positive term series.
3. Testing the absolute convergence of an alternating series and comment about conditional convergence.
4. Practical problems on the convergence of series with arbitrary terms.
5. Testing the convergence/divergence/oscillation behavior of sequences of real numbers.
6. Determine the lub and glb of the subset of real numbers and observe whether they belong to the set or not.

Suggested Evaluation Methods	
InternalAssessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write up and execution of the program

PartC-Learning Resources

Recommended Books:

1. T. M. Apostol (2008). *Mathematical Analysis: A Modern Approach to Advanced Calculus*. Pearson Education.
2. Charalambos D. Aliprantis& Owen Burkinshaw(1998). *Principles of Real Analysis* (3rd edition). Academic Pres.
3. Robert G. Bartle & Donald R. Sherbert (2015). *Introduction to Real Analysis* (4th edition).Wiley India.
4. Gerald G. Bilodeau, Paul R. Thie& G. E. Keough (2015). *An Introduction to Analysis* (2nd edition), Jones and Bartlett India Pvt. Ltd.
5. E. Hewitt & K. Stromberg (2013). *Real and Abstract Analysis*. Springer-Verlag.
6. K. A. Ross (2013). *Elementary Analysis*: *The Theory of Calculus* (2nd edition). Springer.
7. Walter Rudin. *Principles of Mathematical Analysis* (3rd edition), Tata McGraw Hill.
8. R. R. Goldberg (1970). *Real Analysis*. Oxford & I. B. H. Publishing Co., New Delhi.
9 Shanti Narayan & P. K. Mittal (2005). *A Course in Mathematical Analysis* . S. Chand and company, New Delhi.
10. S. C. Malik & S. Arora (2021) . *Mathematical Analysis*. Wiley Eastern Ltd., Allahabad.

MCC-10 Mechanics-I

Session: 2023-24 (Scheme), 2025-26 (Syllabus)	
PartA - Introduction	
Subject	Mathematics
Semester	V
Name of the Course	Mechanics-I
Course Code	B23-MAT-502
CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	MCC
Level of the course	300-399
Pre-requisite for the course (ifany)	Mathematics as a subject at level 5.0
CourseLearningOutcomes(CLO):	After completing this course, the learner will be able to: 1. Comprehensive, factual and theoretical knowledge of the basic concepts of forces, their resultant, moments and couples and to attain the problem solving skill for scientific problems. 2. Have deeper knowledge and understanding of the concepts of friction and laws of friction, centre of mass and centre of gravity and to solve problems related to these concepts. 3. Gain knowledge of concepts of dynamics like velocity, acceleration and angular velocity, simple harmonic motion and to develop the skill of solving simple dynamical problems within the chosen fields of learning. 4. Understand and learn the problems based on concepts of Newton's laws of motion, work, power, energy and apply them to solve related problems in real life.

CLO 5 is related to the practical component of the course.	5.Toattain cognitive and technical skills required for solving practical problems and case studies related to forces, couples, moments, velocity, acceleration, simple harmonic motion, Newton's laws of motion, power and energy. Have hands on skill to create simple program in MATLAB/SCILAB or other softwares to calculate resultant of forces, acceleration, velocity, coefficient of friction, angle of friction, work done, energy and power.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End term Examination Marks	50	20	70
Examination Time	3 Hours	3 Hours	

Max. Marks:100

PartB-Contentsofthe Course

Instructions for Paper- Setter

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

Unit	Topics	Contact Hours
I	Composition and resolution of forces, Parallel forces, Moment of force about a point and a line, Couple, Moment of couple about a point and a line.	12
II	Concept of friction, Laws of friction, Concepts of centre of mass and centre of gravity, Centre of gravity of a uniform arc, plane area and solids of revolution.	12

III	Velocity and acceleration of a particle along a curve: radial and transverse components, tangential and normal components, Relative velocity, Angular velocity and acceleration, Simple harmonic motion, Elastic string.	12
IV	Newton's laws of motion, Work, Power and Energy.	12
	Practical	
	The practical component of the course has two parts, Problem Solving and Practical's using MATLAB/SCILAB software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program. **(A) Problem Solving- Questions related to the following problems will be worked out and record of those will be maintained in the Practical Notebook:** 1. Practical problems to find resultant and resolution of forces. 2. Practical problems based on Lami's theorem and its converse. 3. Practical problems on equilibrium of a number of concurrent forces. 4. Practical problems to find moment of couples.	30

	5. Practical problems on motion of a particle attached to an elastic string. 6. Practical problems on motion of two bodies connected by a string. 7. Practical problems based on principle of conservation of energy. **(B) The following practical will be done using MATLAB/SCILAB or other softwares and record of those will be maintained in the practical note book:** 1. To find magnitude and resultant of given forces. 2. To find ratio of magnitude of forces using Lami's theorem. 3. To find coefficient of friction, resultant friction, angle of friction. 4. To find limits between which a force lie in order to keep a body in equilibrium on a rough inclined plane. 5. To find magnitude and direction of velocity, acceleration along a plane curve. 6. To find magnitude and direction of radial velocity, transverse velocity, radial acceleration, transverse acceleration along a plane curve. 7. To find magnitude and direction of tangential velocity, normal velocity, tangential acceleration, normal acceleration along a plane curve. 8. To find work done by a constant force, variable force and in stretching an elastic string. 9. To find rate of doing work (power). 10. To find kinetic energy and potential energy of a body.	

Suggested Evaluation Methods	
Internal Assessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practical 20** Lab record, viva-voce, write up and execution of the program

PartC-Learning Resources

Recommended Books:

1. Stephan J. Chapman (2020). *MATLAB Programming for Engineers* (6th edition). Cengage Learning.
2. William Palm Lii (2017). *A concise introduction to MATLAB* (2nd edition). Tata Mcgraw-Hill Education.
3. RudraPratap (2010). *Getting Started with MATLAB:A quick introduction for scientists and engineers*. Oxford University Press.
4. A. S. Ramsey (2009). *Statics*. Cambridge University Press.
5. A. S. Ramsey (2009). *Dynamics*. Cambridge University Press.
6. S.L. Loney (2006). *An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies*. Read Books.
7. A.P. Roberts (2003). *Statics and Dynamics with Background in Mathematics*. Cambridge University Press.
8. S.L. Loney (1995). *An Elementary Treatise on Statics*, Radha Publishing House.
9. P.L. Srivastava (1964). *Elementary Dynamics*. Ram NarainLal, Beni Prasad Publishers Allahabad.
10. R. S. Varma (1962). *A Text Book of Statics*. Pothishala Pvt. Ltd.
11. J. L. Synge & B. A. Griffith (1949). *Principles of Mechanics*. McGraw-Hill.

DSE-2 Linear Programming

Session: 2023-24 (Scheme), 2025-26 (Syllabus)	
Part A – Introduction	
Subject	Mathematics
Semester	V
Name of the Course	Linear Programming
Course Code	B23-MAT-503
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE
Level of the course	300-399
Pre-requisite for the course (if any)	Mathematics as a subject at level 4.0
Course Learning Outcomes (CLOs):	**After completing this course, the learner will be able to:** 1. Understand the concepts of linear programming problems (LPP) and all other associated concepts. Learn to analyze and solve linear programming problems of real life situations using graphical method. 2. Have the procedural knowledge of Simplex method and attain the skills to apply knowledge of simplex method in solving real life LPP. Learn the techniques of Two-phase method and Big-M method. 3. Understand the concepts of dual problems, duality theorem and to attain skills to solve linear

CLO 5 is related to the practical component of the course.	programming problems by making use of duality theorem. 4. Have the procedural knowledge of Transportation problems and Assignment problems. Acquire the skills to solve these problems by using different LPP methods. 5. Attain cognitive and technical skills required to analyze scientific and social problems as linear programming problems and solving them by applying learnt techniques.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Examination Marks	50	20	70
Examination Time	3 Hours	3 Hours	

Max. Marks: 100

Part B- Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

Unit	Topics	Contact Hours
I	Linear Programming Problems: Definition, Objective function, Constraints, Canonical and standard forms. Graphical approach for solving some linear programming problems, Limitations of graphical method.	12

	Convex and polyhedral sets, Extreme points, Basic solutions, Basic feasible solutions. Correspondence between basic feasible solutions and extreme points.	
II	Theory of simplex method, Concept of initial basic feasible solution, Optimality criterion, Improving a basic feasible solution, Unboundedness. Simplex algorithm and its tableau format, Artificial variables, Two-phase method, Big-M method. Relation between maximization and minimization problems, Solving linear programming problems using simplex algorithm.	12
III	Formulation of the dual problem, Duality theorems, Unbounded and infeasible solutions in the primal, Solving the primal problem using duality theory.	12
IV	Transportation Problem: Definition and formulation, Methods of finding initial basic feasible solutions, North West corner rule, Least cost method, Vogel's Approximation method. Assignment Problem: Mathematical formulation and Hungarian method of solving.	12
Practical		
	The practical component of the course has two parts, Problem Solving and Practical's using MATLAB/SCILAB or other Statistical software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program. **Part A:** Problem Solving-Questions related to the practical	30

applications based on following problems will be worked out and record of those will be maintained in the Practical Note Book:

1. To solve Linear Programming Problems using Graphical method with

(i) Unbounded solution.
(ii) Infeasible solution.
(iii) Alternate or multiple solutions.

2. Solving LPP using Simplex method with
(i) Unrestricted variables.
(ii) Infeasible solution.

3. To solve Linear Programming Problem by Simplex method with unique solution or with unbounded solution.

4. To solve Linear Programming Problem by Two Phase method.

5. To solve Linear Programming Problem by Big M-Method.

6. To solve Linear Programming Problem using duality.

7. To obtain an optimal solution by Dual Simplex Method.

8. To determine optimal solution of a transportation problem using Vogel's method.

9. To determine optimal solution of transportation problem using (u v) method.

10. To determine an initial basic feasible solution of transportation problem by matrix method.

11. To determine solution of Allocation problems using Assignment model.

Part B: Implementation of above mentioned problem solving through MATLAB/SCILAB or other Statistical softwares.

Suggested Evaluation Methods	
Internal Assessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write-up and execution of programs

Part C-Learning Resources

1. F. S. Hillier, G. J. Lieberman, B. Nag and P. Basu (2021). *Introduction to Operations Research* (11th Edition). McGraw-Hill Education.
2. Hamdy A. Taha (2021). *Operations Research: An Introduction* (10th Edition). Pearson.
3. M. S. Bazaraa, J.J. Jarvis and H. D. Sherali (2010). *Linear Programming and Network Flows* (4th Edition). John Wiley & Sons Inc.
4. P. R. Thie and G. E. Keough (2008). *An Introduction to Linear Programming and Game Theory* (3rd Edition). Wiley Interscience.
5. G. Hadley (2002). *Linear Programming*. Narosa Publishing House.

DSE-2 Computer Programming Session: 2023-24 (Scheme), 2025-26 (Syllabus) Part A – Introduction	
Subject	Mathematics
Semester	V
Name of the Course	Computer Programming
Course Code	B23-MAT-504
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE
Level of the course	300-399
Pre-requisite for the course (if any)	Mathematics as a subject at level 5.0
Course Learning Outcomes (CLOs):	**After completing this course, the learner will be able to:** 1. Have a deeper knowledge and understanding of the concept of mathematical problem solving using computer programming, program design, documentation, compilation, debugging, linking and types of errors in programming. 2. Gain the knowledge and familiarize with the concepts of identifiers, constants, variables, data types, operators, input/output functions in C/C++ programming language. Attain the skills to write and execute programs in C/C++ using programming tools. 3. Have a deeper knowledge and understanding of

CLO 5 is related to the practical component of the course.	decision control statements, loops structures, multidimensional arrays and dynamic arrays in C/C++ programming language. 4. Gain the knowledge and deeper understanding of functions, pointers, strings and files in C/C++ language. Attain the programming skills to solve scientific and practical problem using programming tools. 5. Attain skills of writing codes in the C/C++ programming language. Have hands-on experience to run and debug programs in C/C++ for different mathematical and other practical problems of daily or scientific use.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Examination Marks	50	20	70
Examination Time	3 Hours	3 Hours	

Max. Marks: 100

Part B- Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

Unit	Topics	Contact Hours
I	Planning the Computer Program: Concept of problem solving, Problem definition, Program design, Debugging, Types of errors in programming, Documentation. Techniques of Problem Solving: Flowchart, Algorithms, Pseudo code, Decision table, Structured programming concepts, Programming methodologies viz. top-down and bottom-up programming. Computer Languages: Analogy with natural language, Machine language, Assembly language, High level language, Compiler, Interpreter, Assembler, Characteristics of a good programming language.	12
II	Basic Structure of programming in C/C++, Creating C/C++ source file, Editing, Compiling, Debugging, linking etc., Tokens, Keywords, Identifiers, Constants and Variables in C/C++, Scope and lifetime of variables, Data types in C/C++, Operators and Enum in C/C++, Operators precedence, Arithmetic Expressions, Input/ Output functions in C/C++.	12
III	Decision making using IF statement, Types of IF-ELSE block, Switch case block. Loop structures: While loop, Do-While Loop, For Loop, Continue statement, Break statement. Introduction of Array, Multidimensional Arrays, Dynamic Arrays.	12
IV	Concept of function in C/C++, User defined function, System defined function, Types of parameters passing in function. Implementing string variables, String handling functions in C/C++. Need of Pointers, Types of pointers, Pointers expressions, Arrays of Pointers, Pointers and Functions, File handling	12

	using C/C++	
Practical		
	This course has programs, based on Programming in C/C++. The examiner will set 4 programs at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to execute two programs. The evaluation will be done on the basis of practical record, viva-voce, write-up and execution of the program. **Practicals**: The following practicals will be done using the programming language C/C++ and record of those will be maintained in the practical Note Book: 1. Program to find the largest number among n input numbers. 2. Program to find first nPrime Numbers. 3. Program to print hollow pyramid star pattern. 4. Program to convert a decimal number to binary. 5. Program to generate Fibonacci Triangle. 6. Programs to find sum of an AP and GP Series. 7. Program to remove Duplicate Element in an Array. 8. Program to check whether a two dimensional array is a Sparse Matrix. 9. Find Norm and Trace of a Square Matrix. 10. Program to find GCD of two Numbers using Recursion. 11. Program to check if input character is a vowel using Switch Case. 12. Program to Check if a given string is Palindrome. 13. Program to Count the number of vowels & consonants in a sentence. 14. Program for dynamic memory allocation using malloc().	30

	15. Program to swap two numbers using Pointers. 16. Program for accessing array elements (Traversing array) by incrementing a Pointer. 17. Program for Pointer to a Function. 18. Program for sorting an array. 19. Program for searching an element in an array.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write-up and execution of programs

Part C-Learning Resources

Recommended Books:

1. E. Balagurusamy (2020). *Object Oriented Programming with C++* (8th Edition). McGraw Hill Education.
2. E. Balagurusamy (2019). *Programming in ANSI C* (8th Edition). McGraw Hill Education.
3. D.S. Malik (2017). *C++ Programming: From Problem Analysis to Program Design* (8th Edition). Cengage Learning.
4. B. Gottfried (2017). *Programming with C (Schaums Outline series)* (3rd Edition). McGraw Hill Education.
5. R. Thareja (2016). *Computer Fundamentals and Programming in C* (2nd Edition), Oxford University Press.
6. S. Prata (2015). *C++ Primer Plus* (6th Edition). Pearson Education India.
7. B.W. Kernighan and D.M Ritchie (2015). *The C Programming Language* (2nd Edition). Pearson Education India.
8. V. Rajaraman (1994). *Computer Programming in C*. Prentice Hall of India.

DSE-3 Number Theory and Cryptography

Session: 2023-24 (Scheme), 2025-26 (Syllabus)	
PartA – Introduction	
Subject	Mathematics
Semester	V
Name of the Course	Number theory and cryptography
Course Code	B23-MAT-505
CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE
Level of the course	300-399
Pre-requisite for the course (ifany)	Level 200-299
CourseLearningOutcomes(CLOs):	After completing this course, the learner will be able to: 1. Understand the notion of divisibility, Euclidean algorithim, congruences and some applications to factoring. 2. Have knowledge of Finite fields, quadratic residues and quadratic reciprocity. 3. Have deeper knowledge and understanding of cryptosystems and enciphering matrices. 4. Understand and solve problems related to Public key cryptography, RSA, discrete log and knapsack problem.

CLO 5 is related to the practical component of the course.	5. Attain cognitive and technical skills required for solving practical problems related to Euclidean algorithim, linear congruences, divisibility, finite field, Deciphering the ciphertext, integer factorization, RSA encryption and decryption functions.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End term Examination Marks	50	20	70
Examination Time	3 Hours	3 Hours	

Max. Marks:100

PartB-Contentsofthe Course

Instructions for Paper- Setter

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

Unit	Topics	Contact Hours
I	Numbers in different bases, divisibility and the Euclidean algorithim, congruences, some applications to factoring.	12
II	Finite fields, quadratic residues and quadratic reciprocity.	12
III	Some simple cryptosystems, enciphering matrices.	12

IV	Public key cryptography, RSA cryptosystems, discrete log and knapsack problem.	12
	Practical	
	The practical component of the course has two parts, Problem Solving and Practical's using MATLAB/SCILAB or other Statistical software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program. **Part A:** Problem Solving-Questions related to the practical applications based on following problems will be worked out and record of those will be maintained in the Practical Note Book: 1. To find the gcd using Euclidean algorithim. 2. Find common solution of linear congruences using Chinese remainder theorem. 3. Checking the divisibility of an integer by another integer. 4. Find the generator of a finite field. 5. To find the square root of a number in finite field. 6. Check that a given number is quadratic residue or quadratic non residue modulo a prime number. 7. Deciphering the ciphertext.	30

	8. Integer Factorisation. 9. Find the smallest field extension of F_5 which contains all the roots of the polynomial $X^2 + X + 1$. 10. Given two prime number p and q find the modulus n and the public and private keys for RSA encryption and decryption. 11. Implement the RSA encryption and decryption functions in a problem. 12. Given two elements a and b in a finite field F_p, compute their sum, product, and multiplicative inverse. **Part B:** Implementation of above mentioned problem solving through MATLAB/SCILAB or other softwares.	

Suggested Evaluation Methods

InternalAssessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam	**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write up and execution of the program

PartC-Learning Resources

Recommended Books:

1. N. Koblitz, (1994). *A Course in Number Theory and Cryptography* (2nd edition). Springer-Verlag.

2. M. W. Baldoni, C. Ciliberto, G. M. PiacentiniCattaneo, (2009). *Elementary Number Theory, Cryptography and Codes*. Springer Berlin, Heidelberg.

3. W. Stallings, (2017).*Cryptography and network security* (7th edition). Pearson Education.

DSE-3 Integral Transforms and Fourier Analysis

Session: 2023-24 (Scheme), 2025-26 (Syllabus)	
Part A – Introduction	
Subject	Mathematics
Semester	V
Name of the Course	Integral Transforms and Fourier Analysis
Course Code	B23-MAT-506
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE
Level of the course	300-399
Pre-requisite for the course (if any)	Mathematics as a subject at level 5.0.
Course Learning Outcomes (CLO):	**After completing this course, the learner will be able to:** 1. Gain the knowledge and understanding of Laplace transforms, Inverse Laplace transforms, their properties and convolution theorem. 2. Have the knowledge of Fourier series, Fourier sine and cosine series, Fourier half range series and absolute and uniform convergence of Fourier series. Learn Parseval's identity and Bessel's inequality. Attain skills to make use of Fourier series in scientific problem solving. 3. Gain the deeper knowledge of Fourier transforms, inverse Fourier transforms, their properties and Convolution theorem. Learn about the concept of finite Fourier transforms, inverse finite Fourier transforms

	and attain the skills to apply Fourier transforms techniques to solve mathematical and scientific problems. 4. Have the procedural knowledge and attain the skills to solve differential equations, partial differential equations, boundary value problems and integral equations using Integral transforms.
CLO 5 is related to the practical component.	5. Attain the cognitive and technical skills required for performing and accomplishing complex tasks related to solution of differential equations, boundary value problems and integral equations using Laplace transforms and Fourier Transforms. Acquire analytical and numerical skills to solve mathematical and scientific models involving Integral transforms.

	Theory	Practical	
Credits	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Exam Marks	50	20	70
Examination Time	3Hrs	3Hrs	

Max. Marks: 100

Part B-Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

Unit

1

Unit	Topics	Contact Hours
I	Introduction to Integral transforms. Laplace transforms: Existence theorem for Laplace transforms, Linearity, change of scale and shifting properties of the Laplace transforms, Laplace transforms of some standard functions, Laplace transforms of derivatives and integrals, Differentiation and integration of Laplace transforms, Laplace transforms of periodic functions and some special functions. Convolution theorem, Inverse Laplace transforms and its properties.	12
II	Fourier series, Fourier series of even and odd functions, Fourier half-range series, Fourier cosine and sine series, Parseval's identity, Differentiation and integration of Fourier series, Absolute and uniform convergence of Fourier series, Bessel's inequality, the complex form of Fourier series.	12
III	Fourier transforms, Fourier sine and cosine transforms, Linearity, Change of scale and Shifting properties, Fourier transforms of derivatives, Modulation theorem, Relation between Fourier and Laplace transforms, Convolution theorem for Fourier transform, Parseval's identity for Fourier transforms, , Finite Fourier transform, Inversion formula for finite Fourier transforms. Inverse Fourier transforms, Inverse Fourier sine and cosine transforms.	12
IV	Applications of Laplace transform in obtaining solutions of ordinary differential equations and integral equations. Solution of integral equation by Fourier sine and cosine transforms, Applications of infinite and finite Fourier	12

	transforms to boundary value problems.	
	Practical	
	The practical component of the course has two parts, Problem Solving and Practical's using MATLAB/ SCILB/MAXIMA software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program. **(A) Problem Solving-** Questions related to the following problems will be solved and record of those will be maintained in the Practical Notebook: 1. Practical problems to determine Laplace transform. 2. Practical problems of finding inverse Laplace transform. 3. Practical problems for finding Fourier half-range series. 4. Practical problems for finding Fourier cosine and sine series. 5. Practical problems for finding finite Fourier transform. 6. Practical problems to solve differential equations by Laplace transform method. 7. Practical problems to solve partial differential equations by Fourier transform method. 8. Practical problems to solve integral equations by Fourier transform method.	30

	(B) The following practicals will be done using MATLAB/ SCILAB/MAXIMA software and record of those will be maintained in the practical note book: 1. Practical problems for computing Laplace transforms of symbolic expressions with or without specifying independent and transformation variables. 2. Practical problems for computing Laplace transform of Dirac and Heaviside function. 3. Practical problems for computing Inverse Laplace of symbolic expressions. 4. Practical problems for computing Fourier and Inverse Fourier transforms of symbolic expressions. 5. Practical problems for computing Fourier transform of Bessel's function. 6. Practical problems based on solving differential equations using Laplace transform. 7. Practical problems based on solving partial differential equations using Fourier transform. 8. Practical problems based on computing Fourier series of odd and even functions.	

Suggested Evaluation Methods	
Internal Assessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write-up and execution of programs

Part C-Learning Resources

Recommended Books:

1. W. Rudin (2017). *Fourier Analysis on Groups*. Dover Publications Inc.
2. J. W. Brown and R.V. Churchill (2011). *Fourier Series and Boundary Value Problems* (8th Edition). McGraw-Hill Higher Education.
3. E. Kreyszig (2011). *Advanced Engineering Mathematics* (10th Edition). Wiley.
4. M.R. Spiegel (2005). *Laplace Transforms*. Schaum's Outline Series. McGraw Hill Education.
5. A. Zygmund (2003). *Trigonometric Series* (3rd Edition). Cambridge University Press.
6. C. K. Chui (1992). *An Introduction to Wavelets*. Academic Press.
7. I.N. Sneddon (1974). *The Use of Integral Transforms*. McGraw Hill Inc., US.

CC-6/ MCC-11 Numerical Analysis

Session: 2023-24 (Scheme), 2025-26 (Syllabus)	
Part A – Introduction	
Subject	Mathematics
Semester	VI
Name of the Course	Numerical Analysis
Course Code	B23-MAT-601
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC/MCC
Level of the course	300-399
Pre-requisite for the course (if any)	Mathematics as a subject at level 4.5
Course Learning Outcomes (CLOs):	**After completing this course, the learner will be able to:** 1. Understand the different types of errors, learn techniques to obtain numerical solutions of algebraic and transcendental equations. 2. Have the knowledge and attain numerical skills to find solutions of system of linear equations by different methods. 3. Gain the knowledge to understand the concept of interpolation and extrapolation. Learn various numerical methods to find the value of function and their derivatives using interpolation concept. 4. Have the procedural knowledge and acquire the

CLO 5 is related to the practical component of the course.	skills to apply numerical methods for evaluating definite integrals. Learn single step and multi-step methods to solve first order ordinary differential equations. 5. Attain cognitive and technical skills required to solve scientific problems by applying numerical techniques. Learn to write and execute program of numerical methods based on C language.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Examination Marks	50	20	70
Examination Time	3 Hours	3 Hours	

Max. Marks: 100

Part B- Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

Unit	Topics	Contact Hours
I	Round-off error and computer arithmetic, Local and global truncation errors, Algorithms and convergence. Numerical methods for solving algebraic and transcendental equations: Bisection method, False position method, Fixed point iteration method, Newton-Raphson	12

	method and Secant method. Newton's iterative method for finding nth root of a number.	
II	Numerical methods for solving simultaneous linear equations: Gauss-elimination method, Gauss-Jordan method, Triangularization method (LU decomposition method), Crout's method, Cholesky decomposition method. Iterative methods: Jacobi's method, Gauss-Seidal method, Relaxation method.	12
III	Finite Differences operators and their relations. Interpolation with equal intervals: Gregory–Newton forward and backward difference interpolations. Interpolation with unequal intervals: Newton's divided difference formulae, Lagrange's Interpolation formulae. Central Differences: Gauss forward and Gauss backward interpolation formulae, Sterling formula, Bessel's formula. Piecewise linear interpolation, Cubic spline interpolation. Numerical Differentiation: First and second derivative of a function using interpolation formulae.	12
IV	Numerical Integration: Newton-Cote's Quadrature formula, Trapezoidal rule, Simpson's one-third and three-eighth rule, Chebychev formula, Gauss Quadrature formula. Numerical solution of ordinary differential equations: Single step methods-Picard's method, Taylor's series method, Euler's method, Runge-Kutta Method. Multiple step methods: Predictor-corrector method, Modified Euler's method, Milne-Simpson's method.	12

	Practical	
	This course has programs, based on Programming in C, related to Numerical methods to solve mathematical problems. The examiner will set 4 programs at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to execute two programs. The evaluation will be done on the basis of practical record, viva-voce, write-up and execution of the program. **Practicals**: The following practicals will be done using the programming language C and record of those will be maintained in the practical Note Book: 1. To find roots of algebraic and transcendental equations using Bisection method. 2. To find roots of algebraic and transcendental equations using Newton Raphson method. 3. To find roots of algebraic and transcendental equations using RegulaFalsi method. 4. To find solution of system of equations using Gauss Elimination method. 5. To find solution of system of equations using Gauss Seidal method. 6. To find approximate value of a function by Newton Forward Interpolation formula. 7. To find approximate value of a function by Newton Backward Interpolation formula. 8. To find approximate value of a function using Lagrange's Interpolation formula.	30

	9. To find first and second order derivatives using interpolation formulas. 10. To evaluate a definite integral using Trapezoidal Rule. 11. To evaluate a definite integral using Simpson 1/3 rule. 12. To evaluate a definite integral using Simpson 3/8 rule. 13. To solve an ordinary differential equation using Euler's method. 14. To find solution of an ordinary differential equation using modified Euler's method. 15. To solve an ordinary differential equation using Runge-Kutta second order and fourth order methods.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write-up and execution of programs

Part C-Learning Resources

Recommended Books:

1. Gupta, R.K, (2019) *Numerical Methods: Fundamentals and Applications* Cambridge University Press.
2. A. Gupta and S.C. Bose (2012). *Introduction to Numerical Analysis* (3rd Edition). Academic Publishers.

3. M.K. Jain, S. R. K. Iyengar and R. K. Jain (2012). *Numerical Methods for Scientific and Engineering Computation* (6th Edition). New Age International Publishers.
4. B. Bradie (2007). *A Friendly Introduction to Numerical Analysis*. Pearson India.
5. C. F. Gerald and P. O. Wheatley (2007). *Applied Numerical Analysis* (7th Edition). Pearson Education India.
6. F.B. Hildebrand (2003). *Introduction to Numerical Analysis* (2nd edition). Dover Publication Inc.
7. R. J. Schilling and S. L. Harris (1999). *Applied Numerical Methods for Engineers using MATLAB and C*. S. Chand (G/L) & Company Ltd.

MCC- 12 Real Analysis

Session: 2023-24 (Scheme), 2025-26 (Syllabus)	
PartA – Introduction	
Subject	Mathematics
Semester	VI
Name of the Course	Real Analysis
Course Code	B23-MAT-602
CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	MCC
Level of the course	300-399
Pre-requisite for the course (ifany)	Courses on Calculus and Advanced Calculus
CourseLearningOutcomes(CLO): CLO 5 is related to the practical component of the course.	**After completing this course, the learner will be able to:** 1. Learn basic theory of Riemann integration, and understand fundamental theorem and mean valuetheoremofintegralcalculus. 2. Understand the notion of improper integral and learn to test the convergence of improper integrals. Apply Leibnitz's rule of differentiation under integral sign to compute various integrals. 3. Have knowledge of distance function (metric) and grasp the basic definitions and theorems based on metric and metric space. Apply the knowledge of distance function to check the convergence of sequence in a metric space. 4. Understand the concepts of continuity, compactness, and connectedness in a metric space and analyze the same on real line with usual metric. 5. Attain cognitive and technical skill required to trace the open (closed) sphere in a metric space and observe the effect of different metrics on the same space. Apply the technical tool to check the convergence of real sequences.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Examination Marks	50	20	70
Examination Time	3 Hours	3 Hours	

Max. Marks:100

PartB-Contentsofthe Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

Unit	Topics	Contact Hours
I	Riemann integral, Integrability of continuous and monotonic functions, The fundamental theorem of integral calculus, Mean value theorems of integral calculus.	12
II	Improper integrals and their convergence, Comparison tests, Abel's and Dirichlet's tests, Frullani's integral, Integral as a function of a parameter. Fourier series: Fourier expansion of piecewise monotonic functions, Properties of Fourier coefficients, Dirichlet's conditions, Parseval's identity for Fourier series, Half range series, Change of intervals.	12
III	Definition and examples of metric spaces, neighborhoods, interior points, limit points, open and closed sets, closure and interior of a set, boundary points, subspace of a metric space, equivalent metrics, Cauchy sequences, completeness, Cantor's intersection theorem, Baire's category theorem, contraction principle.	12
IV	Continuous functions, uniform continuity, compactness for metric spaces, sequential compactness, Bolzano-Weierstrass property, total boundedness, finite intersection property, continuity in relation with compactness, connectedness, components, continuity in relation with connectedness.	12

	Practical	
	The practical component of the course has two parts, Problem Solving and Practical's using Mathematica/ MATLAB/Maple/SCILAB/ Maxima etc. software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLO) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program. **(A) Problem Solving-** Questions related to the following problems will be solved and their record will be maintained in the Practical Notebook: 1. Problem solving to compute upper and lower sums of a bounded function for a given partition of a closed interval. 2. Practical problems to check the Riemann integrability of a bounded function. 3. Problem solving to compute the Riemann integrals of a bounded functions using definition. 4. Practical problems to estimate the value of an integral using mean value theorem. 5. Problem solving to check the convergence of improper integrals. 6. Problem solving to compute the integral using Leibnitz's rule of differentiation under integral sign. 8. Problem solving on the Fourier series expansion of periodic functions. 7. By means of an example demonstrate that a subset which is (a) Open in a subspace need not be open in the space. (b) Closed in a subspace need not be closed in the space. 8. Show by an example that real line with usual metric is not compact.	30

	(B) The following practical's will be done using Mathematica / MATLAB/Maple/SCILAB/Maxima etc.software and their record will be maintained in the practical note book: 1. Trace the open and closed spheres in Euclidean space $\mathbb{R}^n$ for n = 2 and n = 3. 2. Trace the open (closed) sphere for same centre and same radius in $\mathbb{R}^2$ for two different metrics. 3. Problems on convergence of sequences in usual metric space. 4. Problems on definite integral of bounded function on closed interval and verify the same theoretically. 5. Problems on Fourier series expansion of periodic functions. 6. Trace the Cartesian curve and find the area under the curve.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write up and execution of the program

Part C-Learning Resources

Recommended Books:

1. T. M. Apostol (1985). *Mathematical Analysis*. Narosa Publishing House, New Delhi.

2. Charalambos D. Aliprantis& Owen Burkinshaw (1998). *Principles of Real Analysis* (3rd edition). Academic Press.

3. Robert G. Bartle & Donald R. Sherbert (2015). *Introduction to Real Analysis* (4th edition). Wiley India.

4. Gerald G. Bilodeau, Paul R. Thie& G. E. Keough (2015). *An Introduction to Analysis* (2nd edition), Jones and Bartlett India Pvt. Ltd.

5. E. Hewitt & K. Stromberg (2013). *Real and Abstract Analysis*. Springer-Verlag.

6. K. A. Ross (2013). *Elementary Analysis: The Theory of Calculus* (2nd edition). Springer.

7. R. R. Goldberg (1970). *Real Analysis*. Oxford & I. B. H. Publishing Co., New Delhi.

8. Shanti Narayan & P. K. Mittal (2005). *A Course in Mathematical Analysis* . S. Chand and company, New Delhi.

9. S. C. Malik & S. Arora (2021) . *Mathematical Analysis*. Wiley Eastern Ltd., Allahabad.

10. E. T. Copson (1988). *Metric Spaces*. Cambridge University Press.

11. P. K. Jain &Kalil Ahmad (2019). *Metric spaces*. Narosa Publishing House, New Delhi.

12. S. Kumaresan (2011). *Topology of Metric spaces*(2^{nd} edition). Narosa Publishing House, New Delhi.

13. G. F. Simmons(2004). *Introduction to Topology and Modern Analysis*. McGraw –Hill.

14. SatishShirali& H. L. Vasudeva (2006). *Metric spaces*. Springer-Verlag.

DSE-4 Mechanics-II

Session: 2023-24	
PartA - Introduction	
Subject	Mathematics
Semester	VI
Name of the Course	Mechanics-II
Course Code	B23-MAT-603
CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE
Level of the course	300-399
Pre-requisite for the course (ifany)	Course on Mechanics-I
CourseLearningOutcomes(CLO):	After completing this course, the learner will be able to: 1. Gain comprehensive understanding of the necessary conditions for the equilibrium of a body acted upon by forces in plane, and learns the principle of virtual work for a system of coplanar forces acting on a rigid body and central axis. Apply this knowledge to investigate, analyze and solve scientific problems. 2. Have deeper knowledge and understanding of three dimensional force system, central axis, and wrenches and learn about null point, null lines and null planes with respect to a system of forces acting on a rigid body together with the idea of central axis.

CLO 5 is related to the practical component of the course.	3. Have knowledge of projectile motion, particle motion on a smooth or rough path in a plane and apply the knowledge for problem solving. 4. Understand equation of motion of a body moving under central forces, Kepler's laws of the planetary motions and their relations with Newton's laws of Motion. Solve problems of central orbits and planetary motion using procedural knowledge of these laws. 5. Attain cognitive and technical skills to solve practical problems of virtual work, principle of virtual work, wrenches and central orbits. Have hands on skill to create simple program in SCILAB/MATLAB to find time of flight, horizontal range of projectile motion.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End term Examination Marks	50	20	70
Examination Time	3 Hours	3 Hours	

Max. Marks:100

PartB-Contentsofthe Course

Instructions for Paper- Setter

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

Unit	Topics	Contact Hours
I	Analytical conditions of equilibrium of coplanar force, Virtual work.	12
II	Forces in three dimensions, Poinsot's central axis, Wrenches, Null lines and Null planes.	12
III	Projectile motion of a particle in a plane, Motion on smooth and rough plane curves.	12
IV	Central Orbit, Kepler's laws of planetary motion and their relation with Newton's laws of motion.	12
	PRACTICAL	
	The practical component of the course has two parts, Problem Solving and Practical's using SCILAB/MATLAB software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (A) and two questions from the part (B) by taking course learning outcomes (CLO) into consideration. The examinee will be required to solve one problem from the part (A) and to execute one problem successfully from the part (B). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program. **(A) Problem Solving-** Questions related to the following problems will be solved and their record will be maintained in the Practical Notebook: 1. Practical problems to understand principle of virtual work for a system of coplanar forces acting on a	30

	particle. 2. Practical problems to determine equilibrium of a body under coplanar forces. 3. Practical problems to understand wrenches, screw, poinsot's central axis and pitch of the system. 4. Practical problems to find velocity at any point of the trajectory. 5. Practical problems to determine range and time of flight of a particle on an inclined plane. 6. Practical problems to determine central orbits when the law of central force is given. 7. Practical problems related to elliptic, hyperbolic and parabolic orbit. 8. Practical problems to establish the equivalence of Kepler's laws for planetary motion and Newton's law of Gravitation. **(B) The following practicals will be done using SCILAB/MATLAB software and their record will be maintained in the practical note book:** Represent forces in 3D space using vectors. Given a set of forces acting in 3D space, find the resultant force and check for equilibrium. Calculate the moment about different axes and verify if the system is in equilibrium. Simulate the trajectory of a projectile launched at a given angle and initial velocity. Plot the trajectory using MATLAB/SCILAB's plotting functions, and calculate parameters such as time of flight, maximum height (vertex), and range. Write MATLAB/SCILAB code to calculate the time	

	of flight of a projectile launched at a given angle and initial velocity, neglecting air resistance. Verify the result by comparing it with analytical solutions. Determine the maximum height reached by the projectile during its flight using MATLAB/SCILAB. Plot the trajectory and identify the vertex, then calculate the corresponding height. Develop MATLAB/SCILAB code to calculate the horizontal range of a projectile launched at a given angle and initial velocity. Compare the result with analytical solutions and explore the effect of launch angle on range. Study how the initial velocity of the projectile affects its time of flight, maximum height, and range. Plot these parameters as functions of initial velocity using MATLAB/SCILAB.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write up and execution of the program

Part C-Learning Resources

Recommended Books/e-resources/LMS:

12. Stephan J. Chapman (2020). *MATLAB Programming for Engineers* (6th edition). Cengage Learning.
13. William Palm Lii (2017). *A Concise Introduction to MATLAB* (2nd edition). Tata Mcgraw-Hill Education.
14. RudraPratap (2010). *Getting Started with MATLAB:A quick introduction for scientists and engineers.* Oxford University Press.
15. A. S. Ramsey (2009). *Statics.* Cambridge University Press.
16. A. S. Ramsey (2009). *Dynamics.* Cambridge University Press.
17. S.L. Loney (2006). *An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies.* Read Books.
18. A.P. Roberts (2003). *Statics and Dynamics with Background in Mathematics.* Cambridge University Press.
19. S.L. Loney (1995). *An Elementary Treatise on Statics,* Radha Publishing House.
20. P.L. Srivastava (1964). *Elementary Dynamics.* Ram NarainLal, Beni Prasad Publishers Allahabad.
21. R. S. Varma (1962). *A Text Book of Statics.* Pothishala Pvt. Ltd.
22. J. L. Synge & B. A. Griffith (1949). *Principles of Mechanics.* McGraw-Hill.

DSE-4 Classical Mechanics

Session: 2023-24 (Scheme), 2025-26 (Syllabus)

PartA - Introduction

Subject	Mathematics
Semester	VI
Name of the Course	Classical Mechanics
Course Code	B23-MAT-604
CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE
Level of the course	300-399
Pre-requisite for the course (ifany)	Course on Mechanics-I
CourseLearningOutcomes(CLO):	After completing this course, the learner will be able to: 1. Learn calculus of variation, Brachistochrone problem, isoperimetric problems, and geodesic etc. 2. Understand stationary paths of a functional, Euler's equation, variational problems involving functionals depending on multi variables and on higher derivatives with different types of boundary conditions, and solving physical problems based on these cases. 3. Understand the concepts of constaints, generalized coordinates, holonomic and non-holonomic systems in classical mechanics, and Lagrangian and, Hamiltonian mechanics. 4. Understand D'Alembert's Principle and its application, Poisson bracket, Lagrange's equations, Gyroscopic, potential, dissipative forces and their importance in practical problems of mechanics.

CLO 5 is related to component of th

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CLO 5 is related to the practical component of the course.	5. Exploring practical problems of Calculus of variation and Analytical Mechanics inculcate skill to handle real life problems based on these.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End term Examination Marks	50	20	70
Examination Time	3 Hours	3 Hours	

Max. Marks:100

Part B- Contents of the Course

Instructions for Paper- Setter

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

Unit	Topics	Contact Hours
I	Motivating problems of calculus of variations: shortest distance, Minimum surface of revolution, Brachistochrone problem, Isoperimetric problem, Geodesic. Fundamental Lemma of calculus of variation.	12
II	Euler's equation for one dependent function of one and several independent variables, and its generalization to (i) Functional depending on 'n' dependent functions, (ii) Functional depending on higher order derivatives. Variational derivative, invariance of Euler's equations, natural boundary conditions and transition conditions,	12

	Conditional extremum under geometric constraints and under integral constraints . Variable end points.	
III	Free and constrained systems, constraints and their classification. Generalized coordinates. Holonomic and Non-Holonomic systems. Scleronomic and Rheonomic systems. Generalized Potential, Possible and virtual displacements, ideal constraints. Lagrange's equations of first kind, Principle of virtual displacements, Hamilton's Principle, Derivation of Lagrange equations from Hamilton's principle. Extension of principle to nonholonomic systems. Conservation theorems and symmetry properties.	12
IV	Routh's procedure and oscillations about steady motion, The Hamiltonian formulation of relativistic mechanics, The Principle of least action.D'Alembert's principle, Holonomic Systems independent coordinates, generalized forces, Lagrange's equations of second kind. Uniqueness of solution. Theorem on variation of total energy. Potential, Gyroscopic and dissipative forces, Lagrange's equations for potential forces equation for conservative fields. The equations of canonical transformation. Examples of canonical transformation. The symplectic approach to canonical transformations. Poisson brackets and other canonical invariants.	12
	PRACTICAL	
	The examiner will set 4 questions at the time of practical examination asking two questions by taking	30

course learning outcomes (CLOs) into consideration. The examinee will be required to solve two problems. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.

Problem Solving: Questions related to the following problems will be worked out and record of those will be maintained in the Practical Notebook:

1. Practical problems to find geodesics on a surface.
2. Problem solving of isoperimetric problems.
3. Formulation and solution of the variational problems with several variables as functions of a single independent variable.
4. Formulation and solution of the variational problem in which higher order derivatives are involved in a functional.
5. Solve numerical problems related to Lagrange's equation.
6. Formulation and solution of real life situations which uses mathematical knowledge and characteristics of D's Alembert's Principle.
7. Solution of problems based on Lagrange's equation.
8. Solution of problems based on Hamilton's equation.

Suggested Evaluation Methods	
InternalAssessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write up and execution of the program

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. H. Goldstein, C.P. Poole & J.L. Safko (2011). *Classical Mechanics* (3rd edition), Pearson.
2. I.M. Gelfand and S.V. Fomin (2012). *Calculus of Variations*, Dover Publications.
3. S.K. Sinha (2009). *Classical Mechanics*, Alpha Science International Limited.
4. Louis N. Hand and Janet D. Finch (2008). *Analytical Mechanics*, Cambridge University Press.
5. F. Chorlton (2002). *Text Book of Dynamics* 2nd Ed, CBS.
6. F. Gantmacher (1975). *Lectures in Analytic Mechanics*, Mir Publishers.
7. Francis B. Hilderbrand (1992). *Methods of applied mathematics* , Dover Publication.
8. Narayan Chandra Rana&PramodSharad Chandra Joag (1991). *Classical Mechanics*, Tata McGraw Hill.

DSE-5 Discrete Mathematics

Session: 2023-24 (Scheme), 2025-26 (Syllabus)	
PartA – Introduction	
Subject	Mathematics
Semester	VI
Name of the Course	Discrete Mathematics
Course Code	B23-MAT-605
CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE
Level of the course	300-399
Pre-requisite for the course (ifany)	Courses on Algebra up to the level 299
CourseLearningOutcomes(CLOs):	After completing this course, the learner will be able to: 1. Understand the notion of sets, logical connectives, tautologies, theory of inference, permutations, combinations and discrete probability. 2. Have knowledge of relations, lattices, chains and antichains, functions and recursive functions. 3. Have deeper knowledge and understanding of discrete numeric functions, generating functions and recurrence relations. 4. Understand and solve problems related to lattices and algebraic systems, Boolean algebras, Boolean functions and Boolean expressions.

CLO 5 is related to the practical component of the course.	5. Attain cognitive and technical skills required for solving practical problems related to sets, permutations, combinations, relations and Boolean algebra.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End term Examination Marks	50	20	70
Examination Time	3 Hours	3 Hours	

Max. Marks:100

PartB-Contentsofthe Course

Instructions for Paper- Setter

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

Unit	Topics	Contact Hours
I	Sets, countability and cardinality of sets, principle of inclusion and exclusion, multisets, logical connectives, conditional and biconditionals, tautologies, logical equivalences, inference theory, predicate calculus, Euclidean algorithim, permutations, combinations and discrete probability.	12
II	Relations, equivalence relations, partial ordering relations and lattices, chains and antichains, functions, composition	12

	of functions, invertible functions, recursive functions.	
III	Discrete numeric functions, generating functions, combinatorial problems, recurrence relations, linear recurrence relations with constant coefficients, homogeneous solutions, particular solutions, total solutions, solution by method of generating functions.	12
IV	Lattices and algebraic systems, principle of duality, distributive and complemented lattices, boolean lattices, boolean algebras, uniqueness of finite boolean functions and boolean expressions.	12
	Practical	
	The examiner will set 4 questions at the time of practical examination asking two questions by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve two problems. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program. **Problem Solving: Questions related to the following problems will be worked out and record of those will be maintained in the Practical Notebook:** 1. Use of principle of inclusion and exclusion. 2. Checking of equivalence of two propositions. 3. The number of ways to choose three out of seven days with repetitions allowed. 4. Practical problem based on Bayes' theorem. 5. To check that given relation is equivalence relation or not.	30

	6. To check that given relation is partial order or not. 7. Practical problems based on composition of functions and invertible functions 8. Practical problem to find homogeneous solution of recurrence relations with constant coefficients. 9. Find the total solution of the given recurrence relation. 10. To find the generating function of the numeric function. 11. Practical problem based on principle of duality. 12. To check that a given lattice is distributive lattice or not. 13. To check that a given lattice is boolean lattice or not.	

Suggested Evaluation Methods

InternalAssessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write up and execution of the program

PartC-Learning Resources

Recommended Books:

1. C. L. Liu and D. P. Mohapatra (2017). *Elements of Discrete Mathematics* (4th edition). McGraw Hill Education.
2. N. Deo (1979). *Graph Theory*, Prentice Hall of India Pvt. Ltd.
3. S. Lipschutz and M. L. Lipson (2022). *Schaum's Outline of Discrete Mathematics* (4th edition). New York: McGraw Hill.
4. K. H. Rosen (2017). *Discrete Mathematics And its Applications* (7th edition). McGraw Hill Education.

DSE-5 Mathematical Modelling

Session: 2023-24 (Scheme), 2025-26 (Syllabus)	
Part A – Introduction	
Subject	Mathematics
Semester	VI
Name of the Course	Mathematical Modelling
Course Code	B23-MAT-606
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE
Level of the course	300-399
Pre-requisite for the course (if any)	Mathematics as a subject at level 5.0
Course Learning Outcomes (CLOs):	**After completing this course, the learner will be able to:** 1. Gain the knowledge and understanding of the underlying principles and theories related to mathematical modelling. Have the knowledge about the current and emerging issues and latest development related to mathematical modelling. Learn to apply the fundamental analytical techniques and simulation methods to develop insight into system behavior. 2. Have the procedural knowledge to apply ordinary differential equation concept in solving the real world problems based mathematical models related to population dynamics, epidemic and

	compartment problems. 3. Gain the knowledge and understanding to formulate and solve the conceptual mathematical models related to Economics, Medicines, Arms race, Battle, International trade and dynamics problems. 4. Have the procedural knowledge to solve the mathematical models related to Population dynamics and Genetics, Growth models, Decay models, Drug delivery problems etc. using difference equations.
CLO 5 is related to the practical component of the course.	5. Attain the cognitive and technical skills required to develop mathematical models of real life and scientific problems and find their solutions using free and open source software tools.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Examination Marks	50	20	70
Examination Time	3 Hours	3 Hours	
Max. Marks: 100			

Part B- Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

Unit

1

Unit	Topics	Contact Hours
I	matical modelling definition, Need, Classification, Simple ons requiring mathematical modelling, Techniques of matical modelling, Classification of mathematical models, cteristics of mathematical models, Latest development in matical Modelling, Merits and Demerits of Mathematical ling, Quantitative and Qualitative approach of modelling, ptual and Physical models, Models in real world problem.	12
II	ematical modelling through ordinary differential equations rst order, Mathematical modelling in population dynamics, ematical modelling of epidemic and compartment models gh system of ordinary differential equations.	12
III	Mathematical modelling in Economics, Medicines, Arms race, Battle, International trade and dynamics through ordinary differential equations, Mathematical modelling through ordinary differential equation of second order.	12
IV	Mathematical modelling through difference equation: Need, Basic theory, Economics and Finance, Population dynamics and Genetics, Discrete dynamical systems, Linear models, Growth models, Decay models, Drug delivery problems.	12
	Practical	
	This course has programs, based on MATLAB/MATHEMATICA/MAPLE Software, related to Mathematical and scientific models. The examiner will set 4 programs at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to execute two programs. The	30

evaluation will be done on the basis of practical record, viva-voce, write-up and execution of the program.

Practicals: The following practicals will be done using the MATLAB/MATHEMATICA/MAPLE Software and record of those will be maintained in the practical Note Book:

1. Growth model (exponential case only).
2. Decay model (exponential case only).
3. Lake pollution model (with constant/seasonal flow and pollution concentration)
4. Case of single cold pill and a course of cold pills.
5. Limited growth of population (with and without harvesting).
6. Predatory-prey model (basic volterra model, with density dependence, effect of DDT, two prey one predator).
7. Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers).
8. Battle model (basic battle model, jungle warfare, long range weapons).
9. Drug delivery models.
10. Economics Model.

Suggested Evaluation Methods

Internal Assessment:

- **Theory 20**
  - Class Participation: 5
  - Seminar/presentation/assignment/quiz/class test etc.: 5
  - Mid-Term Exam: 10
- **Practical 10**
  - Class Participation:
  - Seminar/Demonstration/Viva-voce/Lab records etc.: 10
  - Mid-Term Exam:

End Term Examination:

- **Theory 50**
  Written Examination
- **Practical 20**
  Lab record, viva-voce, write-up and execution of programs

Part C-Learning Resources

Recommended Books:

1. J.N. Kapur (2021). *Mathematical Modelling* (2nd Edition). New Age International Pvt. Ltd.
2. B. Barnes and G.R. Fulford (2016). *Mathematical Modelling with Case Studies: Using MAPLE and MATLAB* (3rd Edition). Chapman and Hall/CRC.
3. L. Edsberg (2008). *Introduction to Computation and Modeling for Differential Equations*. Wiley.
4. F.R. Marotto (2005). *Introduction to Mathematical Modeling using Discrete Dynamical Systems*. Thomson Brooks/Cole.
5. C.L. Dym (2004). *Principles of Mathematical Modeling*(2nd Edition). Academic Press.
6. E.A. Bender (2003). *An Introduction to Mathematical Modeling*. Dover Publications.
7. G. Fulford, P. Forrester and A. Jones (1997). *Modelling with Differential and Difference Equations*. Cambridge University Press.

SEC-4 Basic Mathematical Techniques

Session: 2023-24 (Scheme), 2025-26 (Syllabus)	
PartA - Introduction	
Subject	Mathematics
Semester	VI
Name of the Course	Basic Mathematical Techniques
Course Code	B23-SEC-406
CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	SEC
Level of the course	200-299
Pre-requisite for the course (ifany)	

CourseLearningOutcomes(CLO):	**After completing this course, the learner will be able to:** 1. Attain theoretical knowledge of Eigen values and Eigenvectors, Geometric and Algebraic multiplicity, Characteristic equation and matrix polynomial. 2. Understand theoretical concepts of numerical methods for solving algebraic and transcendental equations and attain practical skills for their implementation. 3. Gain deep theoretical knowledge of techniques of solving differential equations and technical skills to implement these techniques of realistic problems which arise in all disciplines. 4. Understand theoretical concepts of statistical techniques and attain practical skills for their implementation.
CLO 5 is related to practical component of the course.	5.Gain hand on experience of implementation of basic mathematical techniques for solving practical problems on paper and through either of listed softwares.

	Theory	Practical	Total
Credits	1	1	2
Contact Hours	1	2	3
Internal Assessment Marks	10	5	15
End Term Examination Marks	20	15	35
Examination Time	3 Hours	3 Hours	
	Max. Marks: 50		

Part B-Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 4 parts covering entire syllabus. The examinee will be required to

attempt 5 questions, selecting one question from each unitand the compulsory question.

Unit	Topics	Contact Hours
I	Definition of Eigen values and Eigenvectors, Geometric and Algebraic multiplicity, Characteristic equation and matrix polynomial .Basic algorithm of the Power Method Convergence criteria Inverse Power Method, Shifted Power Method.	4
II	Techniques for solving algebraic and transcendental equations: Newton-Raphson, Chebyshev, derivative free, iterative, Bairstow.	4
III	Numerical techniques for solving ODEs: Euler methods, Runge-Kutta methods (2nd and 4^{th} order), Nystrom method, Adams-Bashforth method. Taylor series method and Runge-Kutta methods for solving system of differential equations.	4
IV	Statistical hypothesis test, t-test for one and two samples, F-test, chi-square test, Statistical methods for data fitting: Linear, multi-linear, non-linear regression.	4
	Practical	
	The practical component of the course involvesproblem solving using MAXIMA/Scilab/SageMath/SPSS software. The examiner will set 4 programs at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to execute two programs. The evaluation will be done on the basis of practical record, viva-voce, write-up and execution of the program. Practicals related to the following problems will be solved using	30

	MAXIMA/Scilab/SageMathsoftwares and record of those will be maintained in the practical note book: 1. Problems based on analytical techniques to solve Eigen values and Eigenvectors. 2. Problems involving numerical techniques to solve Characteristic equation and matrix polynomial. 3. Problems solving by Newton-Raphson method. 4. Problems solving by Chebyshev and Bairstow methods. 5. Solving differential equations by Euler method . 6. Problems solving of differential equations by Runge-Kutta methods. 7. Problems solving by Adams-Bashforth method. 8. Problems solving for linear homogeneous system of differential equations. 9. To apply t -test for testing single mean and difference between means and to obtain their confidence intervals. 10. To apply paired t-test for difference between two means. 11. To apply Chi- square test for goodness of fit. 12. To apply Chi- square test for independence of attributes.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: 4 • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: 6 ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 5 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory** 20 Written Examination ➢ **Practicum** 15 Lab record, viva-voce, write-up and execution of programs.

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Gupta, R.K. (2019) *Numerical Methods: Fundamentals and Applications* Cambridge University Press.
2. M.K. Jain, S.R.K. Iyengar& R.K. Jain (2020). *Numerical Methods: Problems and Solutions* (3rd Edition). New Age International Publishers.
3. S.S. Sastry (2012). *Introductory Methods of Numerical Analysis* (5th Edition).Prentice Hall India Learning Private Limited.
4. P. Kandasamy, K. Thilagavathy, K. Gunavathi (2006). *Numerical Methods*. S. Chand & Company.
5. E.Balagurusamy (2017). *Numerical Methods*. McGraw Hill Education.

DEPARTMENT OF MATHEMATICS
CHAUDHARY RANBIR SINGH UNIVERSITY

Session: 2025-26	
Part A - Introduction	
Subject	Mathematics
Semester	V
Name of the Course	Reasoning
Course Code	B23-MAT-507
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/SEC/VAC)	VOC
Level of the course	100-199
Pre-requisite for the course (if any)	NA
Course Learning Outcomes(CLO): CLO 5 is related to the practical components of the course.	**After completing this course, the learner will be able to:** 1. Gain the skill to analyze and solve letter and number series and to pick odd one out. 2. Understand the concept of coding and decoding. To find the directions and blood relations from the situations. 3. Familiarize and get acquainted with arithmetic reasoning and venn diagrams. 4. Have the knowledge of obtaining water and mirror images and find analogy between words, numbers and figures. 5. Attain the cognitive and technical skills to use analytical reasoning for solving series, words relationship and pattern problems.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
External Assessment Marks	50	20	70
Examination Time	3Hrs	3Hrs	

Max. Marks:100

Part B- Contents of the Course

Instructions for Paper- Setter

Theory Paper: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Verbal Reasoning: Series Completion, Number series, Letter Series, Alpha numeric series, Wrong Letter Series, Repeat Series, Wrong Number Series, Number Analogy, Word Analogy.	12
II	Coding and Decoding: Letter Coding, Number coding, Matrix coding, Place arrangement, Direction sense, Family-based puzzles; Blood Relationships.	12
III	Arithmetic reasoning, Venn diagrams, Logical diagrams, Symbol Substitution.	12
IV	Non-verbal Reasoning: Choosing the odd figure, Word Analogy, Number Analogy, Water Images, Mirror Images.	12
	Practical	

	The examiner will set 4 questions at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve 2 questions. The evaluation will be done on the basis of practical	30
	record, viva-voce, written examination. **Problem Solving: Questions related to the following problems will be solved and record of those will be maintained in the Practical Note Book:** 1. Determination of order of the letters or number in the series. 2. Identification of letter or number which is wrong or misfit in the series. 3. Find out the repeated letter group series. 4. Spotting the odd one out. 5. Coding with letters of alphabets. 6. Mixed coding (both alphabetical and numerical). 7. Depicting the correct direction. 8. Studying the relationship mentioned between the persons and selecting the right relationship. 9. Identification of the most appropriate venn diagram for the given problem. 10. To obtain the water images of figures. 11. To obtain the mirror images of figures. 12. Finding relationship between words using analogy. 13. Finding relationship between numbers using analogy. 14.Finding relationship between figures using non-verbal analogy.	
Suggested Evaluation Methods		

Internal Assessment:	End Term Examination:
➢ **Theory :20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum :10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	▯ **Theory 50** Written Examination ▯ **Practicum 20** Lab record, viva-voce, written examination.

Part C-Learning Resources

Recommended Books:

1. Edgor Thorpe (2018). *A course in mental ability and Quantitative aptitude* (4th edition). Tata McGraw Hill Company, New Delhi.
2. Ravi Chopra (2006). *Logical Critical Analytical Reasoning* (1st edition). Galgotia Publications Pvt. Ltd., New Delhi.
3. R.S. Aggarwal (2018). *A Modern approach to Verbal and Non-verbal reasoning* (2nd edition). S.Chand and Company Ltd., New Delhi.
4. N.K. Sinha (2019). *Reasoning: Verbal, Non-verbal & Analytical* (1st edition). Pearson Education, New Delhi.
5. M.K. Pandey (2009). *Analytical Reasoning* (3rd edition). BSC Pvt. Ltd., Pune, Maharashtra.

DEPARTMENT OF MATHEMATICS
CHAUDHARY RANBIR SINGH UNIVERSITY

Session: 2025-26			
Part A - Introduction			
Subject	Mathematics		
Semester	VI		
Name of the Course	Mathematical Explorations in Numbers and Shapes		
Course Code	B23-MAT-607		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/SEC/VAC)	VOC		
Level of the course	100-199		
Pre-requisite for the course (if any)	NA		
Course Learning Outcomes(CLO): CLO 5 is related to the practical components of the course.	**After completing this course, the learner will be able to:** 1. Understand foundational concepts of numbers, including number types and their properties. 2. Apply coordinate geometry to interpret positions and distances in space. 3. Apply modular arithmetic, divisibility rules, and check-digit systems in real-life problems. 4. Understand basic geometric shapes and their properties, and use geometry to analyze real-world objects. 5. Use tools and technology to explore mathematical concepts.		
Credits	Theory	Practical	Total

	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
External Assessment Marks	50	20	70
Examination Time	3Hrs	3Hrs	
Max. Marks:100			

Part B- Contents of the Course

Instructions for Paper- Setter

Theory Paper: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Number Systems and Basic Geometry: Natural numbers, integers, rational and irrational numbers, real numbers, number line, properties of operations, basic shapes (points, lines, angles, triangles, polygons, circles).	12
II	Prime numbers, HCF, LCM, divisibility rules, Euclidean algorithm, Fibonacci sequence, perfect and amicable numbers, magic squares, tessellations, geometric patterns, congruence, similarity.	12
III	Modular arithmetic, congruences, digital roots, casting out nines, coordinate geometry (distance formula, slope, section formula, symmetry, transformations, map and layout applications).	12
IV	Surface area and volume of solids (cube, cylinder, cone, sphere, cuboid), real-life applications (packaging, architecture), check-digit systems (ISBN, credit card), mathematical games and puzzles.	12
Practical		

	The examiner will set 4 questions at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve 2 questions. The evaluation will be done on the basis of practical record, viva-voce, written examination. **Problem Solving: Questions related to the following problems will be solved and record of those will be maintained in the Practical Note Book:** 1. Test properties of integers and basic operations. 2. Apply factorization, primality tests, HCF/LCM rules. 3. Use modular arithmetic in logic puzzles. 4. Explore number patterns and solve magic square problems. 5. Measure geometric shapes and estimate real-life volumes and areas. 6. Solve real-world puzzles (calendar, barcodes, check digits). 7. Visualize number sequences (Fibonacci, prime distributions). 8. Simulate modular arithmetic operations. 9. Create and analyze floor plans and geometric designs. 10. Simulate geometric transformations and symmetry.	30

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory :20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum :10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination:** □ **Theory 50** Written Examination □ **Practicum 20** Lab record, viva-voce, written examination.

Part C-Learning Resources

Recommended Books:

1. Martin Gardner (1956). *Mathematical Puzzles and Diversions*, Penguin Books.
2. David Wells (1986). *The Penguin Dictionary of Curious and Interesting Numbers*, Penguin Books.
3. George E. Andrews (1994). *Number Theory*, Dover Publications.
4. Richard E. Klima & Neil Sigmon (2006). *Applications of Abstract Algebra with Maple*, CRC Press.
5. Ivan Niven, H.S. Zuckerman, H.L. Montgomery (1991). *An Introduction to the Theory of Numbers*, Wiley (5th Ed.).
6. R.D. Sharma (2024). *Mathematics for Class 10 and 12 – Geometry Sections*, Dhanpat Rai Publications.
7. George W. Hart (2011). *Mathematical Impressions: Geometry in Art*, MAA.
8. Michael Serra (2008). *Discovering Geometry: An Investigative Approach*, Kendall Hunt Publishing.

SEC-2

Session: 2023-24			
Part A - Introduction			
Subject	Mathematics		
Semester	II		
Name of the Course	Calculation Skills with Vedic Mathematics-I		
Course Code	B23-SEC-203		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	SEC		
Level of the course	100-199		
Pre-requisite for the course (if any)	NA		
Course Learning Outcomes (CLOs): CLO 5 is related to the practical components of the course.	**After completing this course, the learner will be able to:** 1. Gain the knowledge of *Sutras* and *Upsutras* from Vedic Mathematics. Perform simple arithmetic calculations with speed and accuracy. 2. Have the procedural knowledge of multiplication of complicated numbers quickly with the aid of Vedic *sutras* and generate tables of any number. 3. Make use of Vedic *sutras* to quickly divide, and find LCM and HCF of many digit numbers. 4. Acquire the cognitive skills to calculate square and cube roots of numbers speedily with accuracy. 5. Attain skills to perform calculations in competitive examinations with speed and accuracy.		
	Theory	Practical	Total
Credits	2	1	3
Contact Hours	2	2	4

Internal Assessment Marks	15	5	20
End Term Examination Marks	35	20	55
Examination Time	3Hrs	3Hrs	

Max. Marks:75

Part B-Contents of the Course

Instructions for Paper- Setter

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 7 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question.

Unit	Topics	Contact Hours
I	History of Vedic Mathematics and introduction to its *Sutras* and *Upsutras*. Addition in Vedic Mathematics: Without Carrying, Dot Meth method subtraction in Vedic Mathematics: *Nikhilam Navatashcaramam Dashatah* (All from 9 last 10). Fraction: Addition and Subtraction.	8
II	Multiplication of two numbers of two digits (*Ekadhikena Purvena* method), Multiplication of two numbers of three digits, (*Ekanyunena Purvena* method, *Urdhva Tiryagbhyam* method, *Nikhilam Navatashcaramam Dashatah* method), Combined Operations, Generating Tables (*Nikhilam*).	**8**
III	Division: *Nikhilam Navatashcaramam Dashatah* (two digits divisor), *ParavartyaYojyet* Method (three digits divisor). Divisibility: *Ekadhikena Purvena* Method (two digits divisor), *Eknunen Purvena* Method (two digits divisor) LCM, HCF.	8
IV	Squares of any two digits numbers: Base method, Squares of numbers ending in 5: *Ekadhikena Purvena* Method.	8

	Square Roots: *Dwandwa Yoga* (Duplex) Method, Square root (four digit number). Cubing: *Yavadunam* Method, Cube root (six digit numbers)	
Practical		
	The examiner will set 4 questions at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve 2 questions. The evaluation will be done on the basis of practical record, viva-voce and written examination. **Problem Solving**-Questions related to the following problems will be solved and record of those will be maintained in the Practical Note Book: 1. Addition of two 5-digit numbers by without carrying and dot method. 2. Subtraction of 5-digit numbers by base method. 3. Multiplication of 2-digit numbers by base method. 4. Multiplication of 3-digit numbers by numbers consisting of all 9s. 5. Multiplication of 3-digit numbers by numbers consisting of all 1s. 6. Multiplication of 3-digit numbers by Vinculum method. 7. Division of 2-digit and 3-digit numbers. 8. Generating table of any number. 9. Square of any 2-digit number by base method. 10. Square of any number ending with 5. 11. Square root of 4-digit numbers. 12. Cube root of 6-digit numbers. 13. LCM and HCF of numbers. 14. Answer checking by digit-sum method.	30
Suggested Evaluation Methods		

InternalAssessment:	End Term Examination:
➢ **Theory 15** • Class Participation: 4 • Seminar/presentation/assignment/quiz/class test etc.: 4 • Mid-Term Exam: 7 ➢ **Practicum 5** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 5 • Mid-Term Exam:	➢ **Theory** 35 Written Examination ➢ **Practicum** 20 Lab record, viva-voce, written examination.

Part C-Learning Resources

Recommended Books:

1. U. S. Patankar and S. M. Patankar (2018). *Elements of Vedic Mathematics.* TTU Press.
2. V.Singhal (2014).*Vedic Mathematics for all ages.* Motilal Banarsidas Publishers.
3. R.K.Thakur (2013).*The Essentials of Vedic Mathematics.* Rupa Publications. New Delhi.
4. P. Tiwari and V.K. Pandey (2012). *Vedic Mathematics - Modern Research Methods.* Campus Books International.
5. S. K. Kapoor (2006).*Vedic Geometry Course.* Lotus Press.
6. A. Gupta (2004). *Power of Vedic Mathematics with Trigonometry.* Jaico Publishing House.
7. S.B.K. Krishna Trithaji(1990). *Vedic Mathematics.* Motilal Banarsidas, New Delhi.

Session: 2023-24	
Part A - Introduction	
Subject	Mathematics
Semester	II
Name of the Course	Numerical Ability Enhancement Skills
Course Code	B23-SEC-225
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	SEC
Level of the course	100-199
Pre-requisite for the course (if any)	NA
Course Learning Outcomes(CLOs):	**After completing this course, the learner will be able to:** 1. Understand real number system, fundamental arithmetical operations, use of BODMAS rule and solve typical expressions accurately and fast. 2. Acquire skill to identify types of given sequences/series and apply suitable method to find a particular term, sum of specific number of terms and practice this learning in real life mathematical problems. 3. To formulate equations for specific mathematical problem and making use of mathematical skills to solve that. 4. Have a deeper and comprehensive understanding of the basic concepts of Percentage, Profit & Loss, Alligation or mixture, Averages and acquire skill to use this knowledge in real life problems
CLO 5 is related to the practical component.	5. Attain cognitive and analytical skills to identify, analyze and generate solutions to realistic problems by exploring procedural knowledge associated with the problems. Have analytical skills to compare and recognize various geometrical figures available in

	surroundings with mathematical figures and determine areas and volumes of the same.		
Credits	Theory	Practical	Total
	2	1	3
Contact Hours	2	2	4
Internal Assessment Marks	15	5	20
End Term Examination Marks	35	20	55
Examination Time	3 Hours	3 Hours	
Max. Marks: 75			

Part B- Contents of the Course

Instructions for Paper- Setter

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 7 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Real number system, Operations on numbers, Tests for divisibility of natural numbers, Decimals, Fractions, Square roots, Cube roots, Surds and indices, Use of BODMAS.	8
II	HCF, LCM of integers, Ratio and Proportion, Progressions: Arithmetic Progression, Geometric Progression, Harmonic Progression with their simple and basic practical applications, Number series completion.	8
III	Percentage, Profit & Loss, Alligation or mixture, Average, Average speed problems, Calendar.	8
IV	Logarithms, Area of Quadrilaterals (Parallelogram, Square, Rectangle, Rhombus, Trapezium), Volume and surface area of Cube, Cuboid, Cylinder, Cone, Sphere and Hemisphere.	8

Practical		
	The examiner will set 4 questions at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve 2 questions. The evaluation will be done on the basis of practical record, viva-voce, written examination.	30
	Problem Solving- Questions related to the following problems will be solved and their record will be maintained in the Practical Notebook: 1. To solve problems related to the simplification of expression involving fractions having use of BODMAS. 2. Practical problems of salary increment, population increase etc. & apply formula for n^{th} term and sum of n terms based on A.P. and G.P. 3. Working out average speed during a trip from a destination to another destination assuming non uniform speed taking at least three variation in magnitude of speed. 4. Practical problems related to ratio and proportion. 5. Practical problems related to two digit numbers and reversal of digits at unit and ten's places. 6. Draw a chart for quadrilateral (Parallelogram, Square, Rectangle, Rhombus, Trapezium) mentioning their properties, surface area and perimeter. 7. Draw 3-D figures Cuboid, Cube, Cylinder, Cone, Sphere and Hemisphere and problems solving for the surface area and volume of these figures. 8. Derive a formula to determine average speed of a person	

	travelling from a destination 'A' to another destination 'B' with a speed of x km/h and returning back with a speed of y km/h . 9. 'M' offers a discount of 25% on a book to 'A' and for the same book, he offers 'B' a discount of 10% and again an additional discount of 15%. Analyze, which has to pay more for the same book. 10. Problem of determining single discount in percent equivalent to successive discount of x %, y% and z %. 11. Problem of determining loss percent when a person sells two similar items, one at a gain of x % and the other at a loss of x %. 12. To solve problem related to the value of an item after 'n' years if it depreciates at the rate of 'r %' per annum , when its present value 'P' is given. 13. Problem of determining the value of an item 'n' years ago if its depreciation rate 'r %' per annum and present value 'P' is given. 14. Problem of percentage reduction in consumption of a commodity if its price increases 'r %' so as not to increase the expenditure. 15. Problem to find the ratio in which two or more ingredients at the given price must be mixed to produce a mixture of a desired price.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory 15** • Class Participation: 4 • Seminar/presentation/assignment/quiz/class test etc.: 4 • Mid-Term Exam: 7 ➢ **Practicum 5** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 5 • Mid-Term Exam:	**End Term Examination:** ➢ **Theory 35** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write up.

Part C-Learning Resources

Recommended Books:

1. R. S. Aggarwal (2022). *Quantitative Aptitude*. S Chand & Company Limited, New Delhi.
2. A. Guha (2020). *Quantitative Aptitude* (7th Edition). Mc Graw Hill Publications.
3. V. Dyke, J. Rogers and H. Adams (2011). *Fundamentals of Mathematics*, Cengage Learning.
4. A.S. Tussy, R. D. Gustafson and D. Koenig (2010). *Basic Mathematics for College Students*. Brooks Cole.
5. C. C. Pinter (2014). *A Book of Set Theory*. Dover Publications.
6. G. Klambauer (1986). *Aspects of calculus*. Springer-Verlag.

DEPARTMENT OF MATHEMATICS
CHAUDHARY RANBIR SINGH UNIVERSITY

Part A - Introduction	
Subject	Mathematics
Semester	IV
Name of the Course	**Foundations of Applied Mathematics**
Course Code	B25-MAT-V406
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/SEC/VAC)	VOC
Level of the course	100-199
Pre-requisite for the course (if any)	NA
Course Learning Outcomes(CLO):	After completing this course, the leaner will be able to: 1.Understand basic algebraic concepts, equations and functions and apply them to solve simple real-life problems. 2.Apply elementary calculus techniques such as limits, differentiation and integration in practical situations. 3,Use matrices and determinants to solve systems of linear equations. 4.Develop analytical and problem-solving skills required for vocational and allied disciplines.
CLO 5 is related to the practical components of the course.	5 Attain cognitive and technical skills required formulating and solving practical problems involving Linear and quadratic equations, factorization, inequalities, algebraic identities.

differentiation, integration, standard integrals, matrices, determinants.

	Theory		Practical	Total
Credits	2		2	4
Contact Hours	2		4	6
Internal Assessment Marks	15		15	30
External Assessment Marks	35		35	70
Examination Time	3Hrs		3Hrs	

Max. Marks:100

Part B- Contents of the Course

Instructions for Paper- Setter

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Linear and quadratic equations, factorization, inequalities, algebraic identities and their applications in solving real-life problems. Concept of functions and elementary graphs.	8
II	Types of functions, graphical representation, limits of simple functions, differentiation and its applications.	7
III	Elementary integration, standard integrals and applications of integration in area calculation and practical situations.	7
IV	Types of matrices, determinants, inverse of matrix and solution of simultaneous linear equations using matrices.	8

Practical

	The examiner will set 4 questions at the time of practical examination	60

	by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve 2 questions. The evaluation will be done on the basis of practical record, viva-voce and written examination.	
	Problem Solving- Questions related to the practical problems based on following topics will be worked out and record of those will be maintained in the Practical Note Book: 1.Problem to find solution of linear and quadratic equations. 2.Problem to find graphical representation of functions and inequalities. 3.Problem to solve numerical examples based on limits and differentiation. 4.Problem to find simple integration and its applications. 5.Problem to find matrix operations and solution of linear equations. 6.Problem to solve application-based algebraic and calculus problems. 7.Problem to perform computational work using basic digital tools.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory :15** • Class Participation: 4 • Seminar/presentation/assignment/quiz/class test etc.: 4 • Mid-Term Exam: 7 ➢ **Practicum :15** • Class Participation:**5** • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:**Nil**	**End Term Examination:** **Theory 35** Written Examination **Practicum 35** Lab record, viva-voce, written examination.

Part C-Learning Resources.

Recommended Books

1. Kreyszig, E. (2011). *Advanced Engineering Mathematics* (10th ed.). Wiley India.
2. Grewal, B. S. (2014). *Higher Engineering Mathematics*. Khanna Publishers, New Delhi.

3. Dutta, K. B. (2004). *Matrix and Linear Algebra*. Prentice Hall of India Pvt. Ltd.
4. Lipschutz, S., & Lipson, M. (2009). *Linear Algebra* (Schaum's Outline Series). McGra Hill.
5. Strang, G. (2016). *Introduction to Linear Algebra*. Wellesley-Cambridge Press.

Part A - Introduction			
Subject	Mathematics		
Semester	V		
Name of the Course	**Statistical & Quantitative Techniques**		
Course Code	B25-MAT-V507		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/SEC/VAC)	VOC		
Level of the course	100-199		
Pre-requisite for the course (if any)	NA		
Course Learning Outcomes(CLO): CLO 5 is related to the practical components of the course.	**After completing this course, the learner will be able to:** 1.Collect, classify and present data systematically and construct frequency distribution tables for real-life situations. 2. Represent data graphically using bar diagrams, histograms and pie charts, and interpret graphical information effectively. 3.Compute measures of central tendency (mean, median and mode) and apply these concepts in real-life data analysis. 4.Understand the concept and importance of dispersion and calculate range, variance and standard deviation to interpret variability in data. 5 Attain cognitive and technical skills required formulating and solving practical problems involving classification and presentation of data, mean, median and mode with applications, dispersion, range, variance		
Credits	Theory	Practical	Total
	2	2	4

Contact Hours	2	4	6
Internal Assessment Marks	15	15	30
External Assessment Marks	35	35	70
Examination Time	3Hrs	3Hrs	

Max. Marks:100

Part B- Contents of the Course

Instructions for Paper- Setter

Theory Paper: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Collection, classification and presentation of data. Frequency distribution, graphical representation of data (bar diagram, histogram, pie chart).	8
II	Measures of central tendency: mean, median and mode with applications in real life data analysis.	7
III	Concept and importance of dispersion. Range, variance and standard deviation Interpretation of variability in data .	7
IV	Formulation of linear programming problems, graphical solution of LPP, feasible region and optimal solution.	8

Practical

	The examiner will set 4 questions at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve 2 questions. The evaluation will be done on the basis of practical	60
	record, viva-voce, written examination.	

Problem Solving: Questions related to the following problems will be solved and record of those will be maintained in the Practical Note Book:

1. Problem to collect, classify and present data in tabular form and construct frequency distribution tables.
2. Problem to draw graphical representation of data using bar diagram, histogram and pie chart.
3. Problem to find measures of central tendency (mean, median and mode) from given data and interpret results in real-life situations.
4. Problem to find measures of dispersion including range, variance and standard deviation and analyze variability of data.
5. Problem to formulate linear programming problems from practical situations.
6. Problem to solve linear programming problems using graphical method, identify feasible region and determine optimal solution.

Suggested Evaluation Methods

Internal Assessment:

- **Theory :15**
  - Class Participation: 4
  - Seminar/presentation/assignment/quiz/class test etc.: 4
  - Mid-Term Exam: 7
- **Practicum :15**
  - Class Participation:**5**
  - Seminar/Demonstration/Viva-voce/Lab records etc.: 10
  - Mid-Term Exam:**Nil**

End Term Examination:

Theory 35

Written Examination

Practicum 35

Lab record, viva-voce, written examination.

Part C-Learning Resources

Recommended Books:

1. Gupta, S. C., & Kapoor, V. K. (2014). *Fundamentals of Mathematical Statistics*. Sultan Chand & Sons, New Delhi.
2. Spiegel, M. R., Schiller, J. J., & Srinivasan, R. A. (2013). *Schaum's Outline of Probability*

and Statistics (4th ed.). McGraw-Hill Education.
3. Goon, A. M., Gupta, M. K., & Dasgupta, B. (2011). *Fundamentals of Statistics* (Vol. I & II). World Press, Kolkata.
4. Taha, H. A. (2017). *Operations Research: An Introduction* (10th ed.). Pearson Education.
5. Anderson, D. R., Sweeney, D. J., & Williams, T. A. (2016). *Statistics for Business and Economics*. Cengage Learning.

Subject	Mathematics
Semester	VI
Name of the Course	**Financial and Computational Skills**
Course Code	B25-MAT-V607
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/SEC/VAC)	VOC
Level of the course	100-199
Pre-requisite for the course (if any)	NA
Course Learning Outcomes(CLO): CLO 5 is related to the practical components of the course.	**After completing this course, the learner will be able to:** 1. Apply concepts of simple interest, compound interest, present value, future value of money, annuities and instalments in solving practical financial problems. 2. Understand applications of financial mathematics in banking and personal financial planning and solve problems related to depreciation, sinking fund, appreciation and growth models. 3. Solve practical numerical problems related to assets, investments and business applications using appropriate mathematical techniques. 4. Use basic numerical approximation techniques to obtain solutions of applied computational problems. 5. Attain cognitive and technical skills required formulating and solving practical problems involving simple interest and compound interest, annuities, sinking fund, appreciation and growth models, data organization,graphical representation.

Credits	Theory	Practical	Total

	2	2	4
Contact Hours	2	4	6
Internal Assessment Marks	15	15	30
External Assessment Marks	35	35	70
Examination Time	3Hrs	3Hrs	

Max. Marks:100

Part B- Contents of the Course

Instructions for Paper- Setter

Theory Paper: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Concept of simple interest and compound interest, present value and future value of money, annuities and instalments.	7
II	Applications of financial mathematics in banking and personal financial planning Methods of depreciation, sinking fund, appreciation and growth models.	8
III	Practical numerical problems related to assets, investment and business applications. Introduction to numerical approximation techniques.	7
IV	Basic spreadsheet operations, use of formulas and functions, data organization, graphical representation and interpretation of results.	8
	Practical	
	The examiner will set 4 questions at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve 2 questions. The evaluation will be done on the basis of practical	60

DEPARTMENT OF MATHEMATICS
CHAUDHARY RANBIR SINGH UNIVERSITY

Session: 2023-24	
Part A – Introduction	
Subject	Mathematics
Semester	IV
Name of the Course	Basic Algebra & Quantitative Techniques
Course Code	B23- MAT-406
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	VOC
Level of the course	100-199
Pre-requisite for the course (if any)	NA
Course Learning Outcomes(CLOs):	After completing this course, the learner will be able to 1. Gain knowledge of the concepts of symmetric, skew-symmetric, Hermitian, skew-Hermitian, Linear dependence and independence of rows and columns of a matrix. Have knowledge of procedure and cognitive skills used in calculating rank of a matrix, eigen values, characteristic equation. 2. Understand consistency of homogeneous and non-homogeneous system of linear equations and to learn cognitive and technical skills required for solving such type of problems using matrices.

	3. Develop cognitive skill to analyze the results of a sample using measures of central tendency and graphical representation (pie charts, frequency polygons,). To design and conduct a survey on a relevant topic of their choice (e.g., favorite leisure activities, dietary habits, etc.). Have procedural knowledge to solve linear programming problems used in everyday life. 4. Have the conceptual knowledge of Basics of operational research, Graphical solution, Simplex method.
CLO 5 is related to the practical component of the course.	5. Attain cognitive and technical skills required formulating and solving practical problems involving rank of a matrix, inverse of a matrix, homogeneous and non-homogeneous system of linear equations, straight lines, mean, mode, median, standard deviation and linear programming problems.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End term Examination Marks	50	20	70
Examination Time	3 Hours	3 Hours	

Max. Marks:100

Part B- Contents of the Course

Sandeep Ravinder Neeru A. Sinha

Instructions for Paper- Setter

The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topics	Contact Hours
I	Symmetric, Skew symmetric, Hermitian and skew Hermitian matrices, Elementary operations on matrices, Rank of a matrix, Inverse of a matrix, Linear dependence and independence of rows and columns of matrix.	12
II	Eigen values, Eigen vectors and characteristic equation of a matrix. Applications of matrices to a system of linear (both homogeneous and non–homogeneous) equations.	12
III	Mean, Mode, Median, Standard deviation, Variance. Bar graphs, Pie charts, Frequency polygons.	12
IV	Basics of operational research. Linear programming problems (LPP): Formulation, Graphical solution, Simplex method.	12
Practical		

The examiner will set 4 questions at the time of practical examination by taking course learning outcomes (CLOs) into consideration. The examinee will be required to solve 2 questions. The evaluation will be done on the basis of practical record, viva-voce and written examination.

Problem Solving- Questions related to the practical problems based on following topics will be worked out and record of those will be maintained in the Practical Note Book:

1. Problems to find the rank of a matrix.
2. Problems to find the eigen values and eigen vectors of a matrix.
3. Problems to find the characteristic equation of a matrix.
4. Problems to solve homogeneous system of linear equations.
5. Problems to solve non–homogeneous system of linear equations.
6. Problems to solve Mean, Mode, Median.
7. Problems to solve Standard deviation and Variance.
8. Problems to solve linear programming problems.
9. Problems to solve Graphical solution.

Suggested Evaluation Methods	
Internal Assessment: ➢ **Theory 20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum 10** • Class Participation: - • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam: -	**End Term Examination:** ➢ **Theory 50** Written Examination ➢ **Practicum 20** Lab record, viva-voce, write up and execution of the program

Part C- Learning Resources

Recommended Books/e-resources:

1) Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence (2022). *Linear Algebra* (5th edition). Prentice Hall of India Pvt. Ltd.
2) S.C. Gupta and V.K. Kapoor (2014). Fundamentals of Mathematical Statistics. S. Chand & Sons, Delhi.
3) K. B. Dutta (2004). *Matrix and Linear Algebra*. Prentice Hall of India Pvt. Ltd.
4) Kanti Swaroop operational Reasearch , S. Chand(1978).
5) S.D Sharma. Operation Research, Kedar Nath Ram Nath (2014).
6) J. V. Dyke, J. Rogers and H. Adams (2011). Fundamentals of Mathematics (10th Edition), Brooks/Cole.
7) A.Tussy, R. Gustafson and D. Koenig (2010). Basic Mathematics for College Students (4th Edition). Brooks Cole.